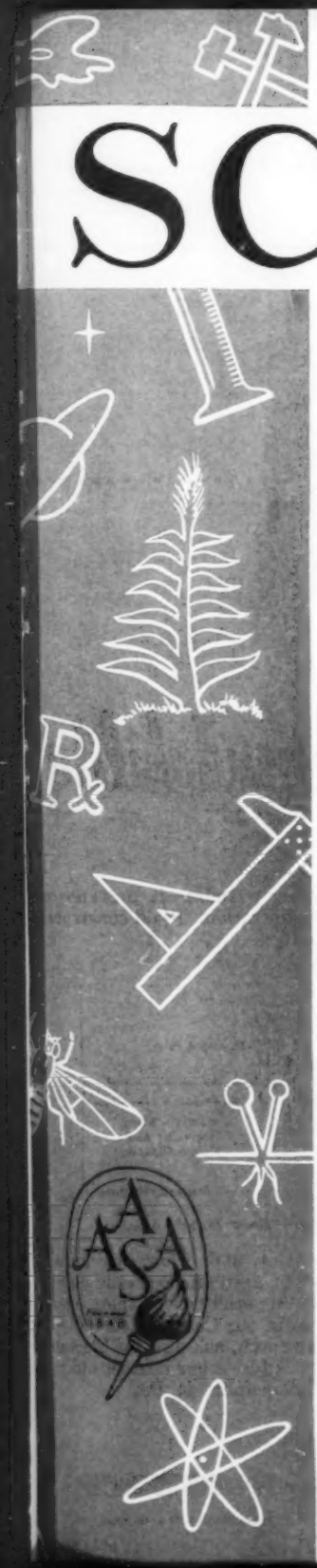

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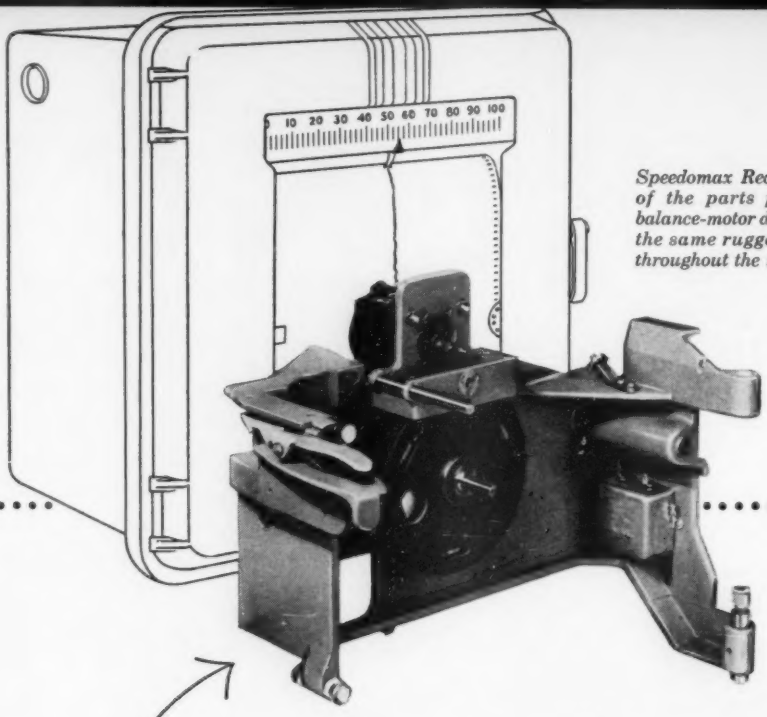

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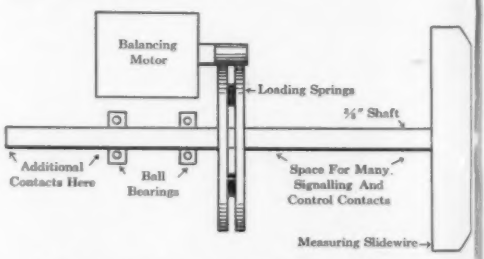

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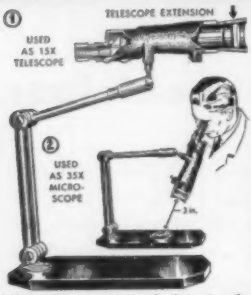

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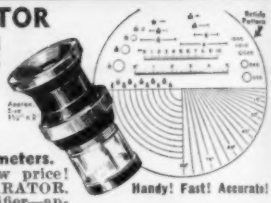

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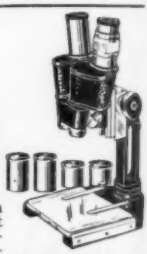

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The Survey of Biological Abstracting

A Survey of Biological Abstracting, supported by funds from the National Science Foundation and other agencies, is being conducted to determine the effectiveness of present abstracting programs. The program is divided into two principal parts: (1) a study of the current effectiveness of abstracting agencies, and in particular of *Biological Abstracts*, in covering the relevant scientific literature; and (2) a determination of the consensus among American and foreign biologists of the merits, defects, and desirable changes in the over-all abstracting program.

The statistical study of the actual effectiveness of the abstracting services is being broken down into four analyses. First, a sample period, 1947–1949 inclusive, was chosen so as to be far enough back to have been finished by the abstracting services, yet recent enough to be representative of present practices. Journals were selected to form a representative sample of subject fields, and the coverage by the abstracting services of articles published during 1947–1949 has been analyzed (a) as to the percentage of articles not abstracted or not indexed, and (b) as to the average interval between the publication of an article and of the abstract of it. The journals are grouped in three ways: journals supplying author's abstracts, and those not doing so; journals of American, or of British, or of foreign language countries; journals wholly biological in content and those only partially biological in content.

Second, a comparative study is being made of the relative proportions of known biological journals, selected as worthy of scientific attention, now being covered by the several abstracting services. The proportion of articles originating in different countries is also being studied.

Third, the comparative coverage of particular subjects is being analyzed. For example, a number of recent bibliographies of specific topics, e.g., bibliographies on Drosophila, Cerebral Circulation, Collagen, Plasma Substitutes, the Pathology and Physiology of Burns, Polychaetous Annelids, and Pituitary-Adrenocortical Function have been checked to determine the number of items in the bibliography which can be located in *Biological Abstracts*; and whenever feasible, the number of items under the same or a similar subject heading in *Biological Abstracts* not to be found in the special bibliography was likewise ascertained.

Fourth, overlapping between abstracting agencies has been studied by taking a particular subject and determining what proportion of the articles thereunder in each abstracting journal is included in the other. *Biological Abstracts* has thus been compared with *Chemical Abstracts* with respect to coverage of the subject of Chemotherapy over the test period; with *Resumptio Genetica* with respect to the coverage of human, animal, and plant genetics, severally; with the *Zoological Record* with respect to articles dealing with species of animals; with the *Geological Indexes* with respect to paleontological articles; and similarly for other subjects with the *Excerpta Medica*, *Berichte über die gesamte Biologie*, *British Abstracts of Chemistry and Physiology*, etc. It is hoped that the survey will be able to include also *Psychological Abstracts*, the *Current List of Medical Literature*, and the *Bibliography of Agriculture* in this part of the study.

A questionnaire has recently been mailed to about 7000 biologists in the United States and abroad by a random sampling of the mailing lists of the Federation, the American Institute of Biological Societies, the American Society of Bacteriologists, the Entomologists, and the biological librarians. Others will be included to assure adequate representation, especially of foreign biologists. The returns will be coded and analyzed by machine; and personal comments will be compiled for use in formulating ultimate recommendations. In order to assure that the questionnaires represent a random and not a biased sample, the returns will be checked against complete censuses of opinion among the biologists of a few selected areas, e.g., a metropolitan area with numerous colleges and universities and research institutions; a small college or two in relatively isolated situations; a large agricultural college in a small midwestern town, etc.

It is hoped that the Survey can be completed this year, and that the final report and recommendations will be published in some journal of wide circulation accessible to all biologists.

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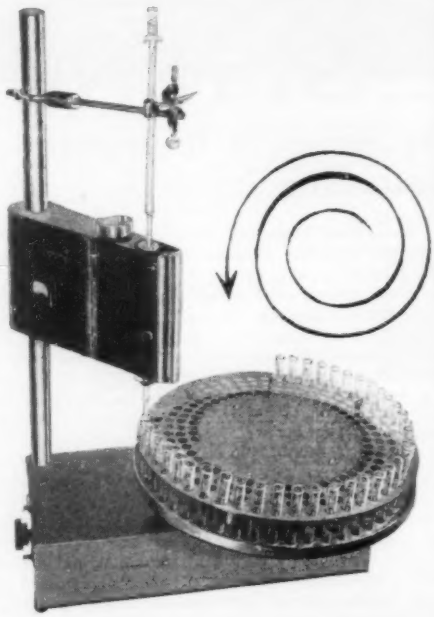

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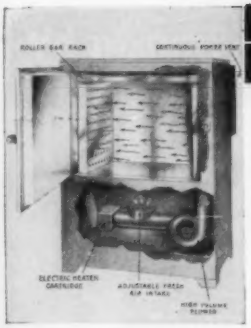

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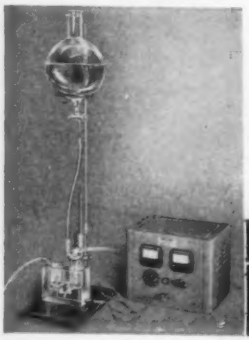

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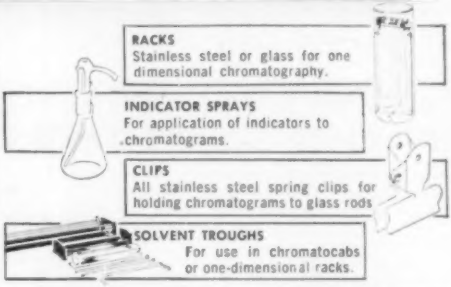

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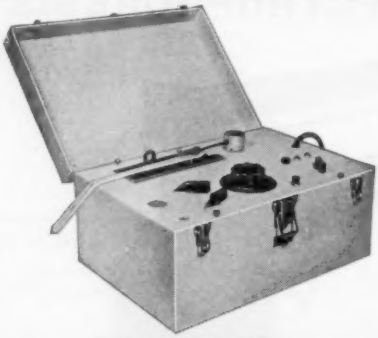

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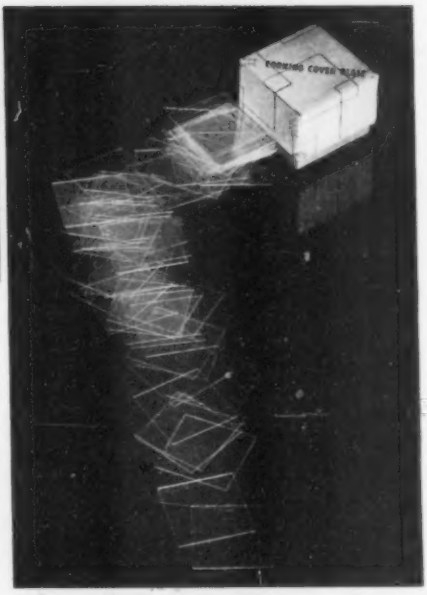

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		15mm	4.46	4.03	3.80	3.57	3.34
		18-22-25mm	3.43	3.09	2.92	2.74	2.57
73780	CIRCLES #2	12mm	4.03	3.62	3.43	3.22	3.03
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The Challenge of Biology

Paul Weiss[1]

Department of Zoology, University of Chicago, Chicago, Illinois

THIS IS THE CENTURY of the biological sciences. The physical sciences have already achieved a high degree of consistency and conceptual maturity. In the life sciences, on the other hand, analytical understanding is still no more than rudimentary, unifying concepts are still scarce, and many fundamental principles remain to be discovered. The major job still lies ahead. At the same time, the urgency of the task grows, as mankind looks expectantly to new advances in agriculture, public health, and medicine, whose rational development depends on biological knowledge and understanding.

The biological sciences strive to measure up to the challenge. They are hitting an ever swifter stride and, being young, move on with optimism to a future full of opportunities and promise of fulfillment. Yes, biology is on the march. Its gathering momentum is gratifying; it also holds its dangers.

For in its fast advance, biology tends to break up into isolated columns, splintering into ever more subdivisions of specialization and particularization. Mastery requires concentration, and concentration is aided by seclusion. Thus, breaking up the larger tasks into narrower fragments is necessary for success. But unless the common goal—the understanding and control of life processes—is constantly kept in view as the beacon for the individual columns by which to chart their courses, they will lose contact, common purpose, and direction. *The unity of life* must find its true reflection in *unity among the biological sciences*. Beyond our preoccupation with our special interests, as anatomists, bacteriologists, cytologists, dendrologists, endocrinologists, geneticists, histologists, immunologists, limnologists, mammalogists, neurologists, oncologists, physiologists, radiologists, serologists, taxonomists, virologists, and zoologists, we must remain, above all, biologists, at least in spirit and allegiance, if not in performance.

Being a biologist is an attitude, not an occupation. Biology has grown in volume and diversity to the point where it would be far beyond the capacity of any one individual to acquire competence in more than a limited sector of the field. Biologists, in the sense of miniature incarnations of universal biological knowledge, no longer exist. Biological science has become a group enterprise with many servants in varied stations. The single-celled organism has evolved into a multicellular one, and its health, survival, and growth depend on the harmonious cooperation of its many specialized members. Anyone contributing to this collective task, constructively, competently, and conscientiously, thus becomes a biologist. Consequently, it takes all kinds of biologists to make the biological world, none of them able to carry on without the others. And biology needs their full diversity.

It needs the observer, the gatherer of facts, the experimenter, the statistician, the theorist, the classifier, the technical expert, the interpreter, the critic, the teacher, the writer. It needs the student of evolutionary history as much as it does the experimental physiologist; the precise recorder of morphological data as much as the analytical biophysicist and biochemist; the investigator of molecular interactions as much as the student of supramolecular organization, of the order of events in space and time. It needs the help of all hands at all stations, from the research man who conceives a new idea, to the assistants who prepare solutions or tend cultures or animals; from the mechanic who builds a new instrument, to the artist or photographer who prepares indelible records of microscopic specimens or physiological tracings; and last, not least, from the man who willingly gives of his time and effort in order to help obtain and distribute some of the most basic tools of science—fellowships, research grants, materials and jobs—to the one who willingly accepts them to good advantage. They all work for a common cause and should feel above the unjustified and undignified popularity contests that center on such monomaniac questions as who is "more important," the "fundamental" or the "applied" scientist; the explorer or the instructor; the technical expert or the philosopher. They are all needed—in their proper stations. And they should be rated not by *what* they are doing but by *how* they are doing it.

Competence, resourcefulness, scholarship, craftsmanship, imagination, self-criticism, discipline, honesty, responsibility, and logical clarity are the only valid criteria of merit; not whether one devotes himself to exploring the vegetation of the Congo or the permeability of a cell membrane. Good work in any line will bring success. Given some luck, discoveries will come abundantly, as Pasteur said, to the "prepared mind." Opportunities are the richer, the wider the field and the more there is yet to be discovered; chances the better, the more freely an individual of good sense can strike out for himself, free from the tyranny of fashion and the lure of popularity. In biology, in its campaign to conquer the unknown, the field is so broad, so much is yet to be discovered, ordered, and explained, and there is so much freedom yet for initiative and self-direction that rich yields await the curious, imaginative, resourceful, and courageous. Yet, as the freshly mined raw materials of

[1] Chairman, Divisional Biology Sequence, University of Chicago; Chairman, Division of Biology and Agriculture, National Research Council.

new knowledge are fed in ever increasing volume into the processes of sorting, polishing, recording, distribution, storing, and application, even those who by inclination or talents have taken stations in this processing network behind the front lines of research will reap their share of credits and rewards, as they themselves take an essential share in the accomplished product: the advance of the biological sciences.

Of course, reward is counted not only in economic terms, but more in terms of intellectual and emotional satisfaction—the thrill of discovery, the pride of achievement, the sense of service to man and his welfare. Being young and in the ascendancy, biology can promise the members of its family more of these rewards than most other fields of science. What is more, being highly diverse and relatively undeveloped, it offers the *individual* more latitude of personal choice and broader opportunity for the expression of his personal talents than older, more standardized and grooved endeavors.

Therefore, biology has room for a very wide range of personalities and trainings; while for its frontline advances it needs the best of brains and eyes, and hands, it is no less dependent on the large corps of comrades in arms who support, consolidate, exploit, and enlarge those advances. All it takes to join these forces is: some aspirations, to point the goal; some inspiration, to point the way; and perspiration, to get you there. What can you get out of it?—a happy and a useful life.

Observations on the Formation and Behavior of "Conjugation" Cells and Large Bodies in *Azotobacter agile*[1]

Norman C. Dondero and Max R. Zelle
Laboratory of Bacteriology, Cornell University, Ithaca, New York

DURING SINGLE-CELL STUDIES on *Azotobacter agile*, strain M.B. 4.4,[2] the development of two unusual cell types—"conjugation" cells and large bodies—was observed. Löhnis and Smith (*1*) reported cellular fusion in Azotobacter, but this was considered by Lewis (*2*) to be incomplete division. The formation of large bodies in *A. agile* M.B. 4.4 was believed by Eisenstark *et al.* (*3*) to be caused by the stimulus of substances in the culture medium. The formation of large bodies was followed by time-lapse, phase-contrast, photomicrography in a *Bacillus* by Schaechter (*4*) to the point of formation of apparently motile granules, and small, nonmotile, occasionally budding elements.

So far as the authors are aware, this is the first report of observations of these forms at close intervals under conditions such that some previously advanced interpretations of the causes could be ruled out. These observations are reported because they offer support to the contention of Lewis and a possible alternative to the interpretation of Eisenstark *et al.*

The strain was routinely carried in stock on slants of modified Karlsson and Barker (*5*) selective medium in which 1 per cent glucose was substituted for 1 per cent ethyl alcohol. The medium was nitrogen free except for that contained in 0.02 per cent yeast extract. An inoculum was transferred in water of syneresis from the base of a slant, by means of a micropipet and micromanipulator (*6*), to the surface of a film of the same medium on a coverslip inverted on a moist chamber, where it could be watched with the microscope. For the initial experiments the moist chamber slides were incubated at 30° C in closed cans containing wet filter paper. For observation, the chambers were removed from the tins and placed on the microscope, which rested on a bench at room temperature. There was considerable loss of water during observation, to the extent that it became difficult to express moisture from the agar with the microneedle. Under these conditions, the viability of the microcultures was, in general, rather low. Many cells either failed to grow and divide, or divided once or twice in the usual manner and then became vacuolated and nonviable on transfer to fresh medium shortly after removal from the tin. It was noticed, in more than six separate instances, that a cell would start to divide in an unusual manner, the first sign of which appeared as a refractile granule near the center of a swollen cell. The granule elongated to become a line across the cell, and shortly after, a cleft appeared in the center of the line and proceeded along it so that the cell divided as in Fig. 1, a–d. Uneven division resulted in earlier separation at one end, thus leaving the two sections at the incompletely divided end attached by a narrow strip and giving the impression of two cells joined by

[1] From investigations supported jointly by Cornell University and the Atomic Energy Commission under contract No. AT(30-1)-1244.

[2] Obtained from A. E. Eisenstark, Oklahoma A. and M. College, Stillwater.

FIG. 1. Stages of division in Azotobacter in the formation of "conjugation" cells.

a tube. These forms, if seen in a stained smear, might easily be interpreted as conjugating cells, since the developmental sequence would not then be apparent. Because of the deterioration of the slide culture it was necessary to test the viability of the paired individuals by transfer to fresh medium by means of a micropipet; none of the transfers showed any signs of viability.

Still more rarely, a ring of four cells (Fig. 1e) was seen to arise by a process similar, in the early stages, to that just described. Before separation at the ends of the cleft, a new division was seen to start in a plane perpendicular to that of the division already in progress. Completion of this type of division was never observed, although it might have occurred.

It is believed that these abnormal divisions were the result of unfavorable environmental conditions induced by the method of handling the cultures, since they were never again seen after the complete apparatus was installed in an incubator room with provision for humidification.

The appearance of large bodies occurred under conditions which seemed favorable to the overwhelming majority of cells among which the large bodies arose. The cells were grown on the same agar as previously mentioned and examined *in situ* in a moist chamber in a humidified room. In populations which were otherwise normal in appearance, there would appear sporadically the abnormally large and irregularly shaped cells from which other normal- and abnormal-appearing cells stemmed. Several such incidents were closely followed and recorded. An account of one of these follows in detail.

Cells from a 48-hr microcolony grown on a coverslip at 30° C were transferred to a fresh coverslip. Abnormal forms did not appear during the first 12 hr of incubation, although a considerable number of normal cells had grown. Single cells were isolated to unoccupied areas of the agar according to routine (*6*) and further incubated for 4 hr. In one of the subcultured microcolonies of about 8 cells, 2 cells about three times normal length were seen. Each cell was again isolated to another portion of the agar. Twenty-one hours later the microcolonies formed from the long cells each contained both normal cells and large bodies. Ten hours later some of the large forms had divided to form more large cells, while others continued to enlarge without division. Large bodies often exceeded 20 μ in length and 10 μ in breadth. Lateral budding was observed in some large bodies, others constricted off the ends, and some divided into several cells simultaneously (Fig. 3a). Most of the cells were limp, flexible, and delicate. Upon rupture by light touches of the microneedle, the content of the cell, consisting of large refractile granules in a liquid of low viscosity, was released upon the surface of the agar where it would persist for a few minutes before disappearing. The released granules had no motion of their own.

The schematic summary of cell relationships (Fig. 2) is based on several pedigrees and illustrates various observed relationships in the lineage of normal and abnormal cells. To sum up the observations, the normally ellipsoidal cells were very stable with respect to morphology, and formed large bodies only at rare intervals. The apparently spontaneous appearance of large bodies was seen, however, in several independent instances. Many of the large bodies died before producing any offspring. However, when offspring were produced, normal cells, large bodies, or both could result. The resulting large bodies would behave in a manner similar to the primary large bodies in that they, in turn, would be nonviable or produce a mixed lineage. The normal-appearing ellipsoidal cells derived from large bodies were of two types—those from which a normally stable line of ellipsoidal cells arose, rarely producing large bodies, and those producing an unstable line of apparently normal cells which formed large bodies at much higher than normal rate. The incidence of large bodies, therefore, was clonal rather than general.

The similarity of the normal-cell large-body relationship to the pedigrees of Hansen and Smith (*7*) for the segregation of types of *Botrytis cinerea* through repeated monospore subculturing is sufficiently striking to suggest that the phenomenon in Azotobacter similarly may have resulted from segregation of dissimilar nuclei in a heterocaryon. Stained preparations of large bodies lent plausibility to this hypothesis since they contained numerous chromatinic structures, presumably nuclei (Fig. 3, a–c). The normal ellipsoidal cells (Fig. 3d) may also be multinucleate, as suggested by the apparently multiple chromatinic structures and inheritance pattern.

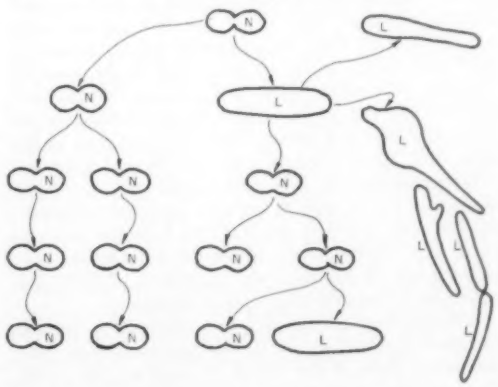


FIG. 2. Schematic relationship of large bodies and normal cells; n = normal, l = large bodies.

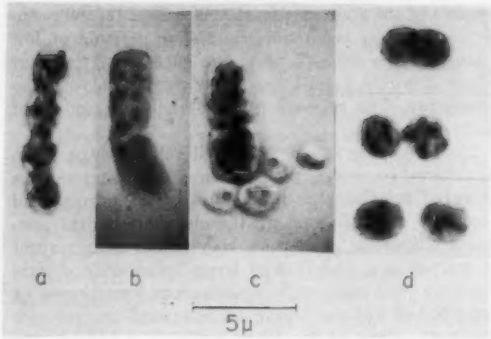


FIG. 3. a–c, Large bodies of *A. agile* M.B. 4.4. In b, the indentation in the side of the cell represents collapse of the cell wall, not incipient cell division. In c, a large body and some smaller cells from the same microcolony. Note the very small cells to the right which have resulted from irregular cell division. In d, normal cells in various stages of cell division. All preparations giemsa stained after treatment with *N*/1 HCl at 58° C for 8 min.

No cell fusions were observed. However, a heterocaryon could be formed by mutation in a multinucleate cell. A satisfactory explanation of the observed phenomena can be made by postulating a mutation which has no effect at low ratios of mutant to normal nuclei, but which interferes with cell division and not with nuclear division when the nuclear ratio exceeds a critical value.

Toxic factors, as the agents responsible for large body formation, were not entirely ruled out by these observations. However, the physical disposition of the cells on the surface of the agar was such that a large body could arise from a cell in direct contact with a normal cell. Because the incidence of large bodies was clonal rather than general, it seems more likely that the expressed effect was genetic rather than environmental.

Since the reported observations were subsidiary to the main purposes of the experiments being undertaken at the time, no further efforts were made to investigate alternative possibilities.

References

1. LÖHNIS, F., and SMITH, N. R. *J. Agr. Research*, **23**, 401 (1923).
2. LEWIS, I. M. *J. Bacteriol.*, **34**, 191 (1937).
3. EISENSTARK, A., WARD, C. B., and KYLE, T. S. *Ibid.*, **60**, 525 (1950).
4. SCHAECHTER, M. *Science*, **116**, 637 (1952).
5. KARLSSON, J. L., and BARKER, H. A. *J. Bacteriol.*, **56**, 671 (1948).
6. ZELLE, M. R. *Ibid.*, **61**, 345 (1951).
7. HANSEN, H. H., and SMITH, R. E. *Phytopathology*, **22**, 953 (1932).

Sergei Nikolaevitch Winogradsky: 1856–1953

Selman A. Waksman

Department of Microbiology, Rutgers University, New Brunswick, New Jersey

SERGEI NIKOLAEVITCH WINOGRADSKY was born September 14, 1856, in the city of Kiev, Russia. His father, N. K. Winogradsky, was a native of Bessarabia, the most southwestern province in Russia. His mother, N. V. Skoropadskaia, came from an old Ukranian Getman family. His father engaged in banking and eventually became director of the first private commercial bank of Kiev. He purchased several estates in the Podol region, in the neighborhood of the town of Gorodok, or Grudok, state of Kamenetz-Podolsk, not far from the city of Proskurov. These estates he combined into one and brought the soil under intensive cultivation, paying special attention to seed selection.

Winogradsky was born and brought up in a large old family house, with an extensive garden, overlooking the river Dnieper. He had two brothers and one sister. His older brother, Alexander Nikolaevitch, received a law education at the University of Kiev, but subsequently became interested in music.

Winogradsky entered the second class of a classical gymnasium at the age of 10 and was graduated from the eighth class, at the age of 16, with a gold medal. To prove his hearty dislike of the bureaucratic atmosphere of the gymnasium, which was characteristic of the Russian middle schools in general, he sold his medal immediately.

In 1873, Winogradsky entered the University of Kiev, where he spent 2 years, at first studying law as his father and elder brother had done, but, tiring of legalistic studies, he soon transferred to the division of natural sciences, in the physico-mathematical faculty. This period at the university left no deep impression upon his development. Although he attended the lectures regularly and passed all his examinations on time, the whole atmosphere of this institution of higher learning offered but little attraction for him.

Science, especially as it was organized at the University of Kiev, failed to satisfy his natural curiosity, and he became interested in music. This led him to the Conservatory of Music at St. Petersburg, where he was admitted to the piano classes of the most brilliant music teacher of that time, Professor Leshetitski, who later became the teacher of Paderewski and of many other famous musicians. Winogradsky developed a deep interest in his work at the conservatory, which left an indelible imprint upon his personality. He soon became convinced, however, that "aesthetic emo-

tions alone, without any activity of the brain, could not satisfy him for very long."

In 1877, Winogradsky entered the natural science faculty of the University of St. Petersburg, which at that time consisted of a group of some of the most brilliant and enthusiastic scientific minds ever gathered at any one time at a Russian institution. Since he was particularly anxious to receive a thorough preparation in chemistry, he began immediately to study analytical chemistry under the leadership of Professor Menshutkin.

On his graduation from the university in 1881, he was invited by the faculty, on the recommendation of the botanist Famintzin, to remain as a candidate in preparation for a professorship. He accepted and, attracted by the epoch-making discoveries of Pasteur and the mycological investigations of deBary and Woronin, began immediately to study microorganisms and their activities.

In 1879, while still an undergraduate, Winogradsky married Z. A. Tichotzkaia, with whom he led a happy married life, which lasted for exactly six decades. The couple had four daughters, three of whom are still living.

Beginning with his graduate work at the university, the life and scientific activities of Winogradsky can be divided into seven periods:

1. *The first St. Petersburg period* (*1881–1884*), when his interest in science matured. Though this may be considered as still a period of intensive training, Winogradsky began and completed his first scientific problem, on microbial variation, which proved to be highly successful. During this period, he worked in the laboratory of plant physiology of the university.

2. *The Strasbourg period* (*1885–1888*), in which he carried out his first investigations on the autotrophic bacteria. The problems dealing with the sulfur and iron bacteria were begun and completed at the botanical laboratory of the university under deBary.

3. *The Zürich period* (*1888–1891*). The study of the organisms concerned in the process of nitrification was begun and nearly completed at the agricultural faculty of the Polytechnicum and at the hygienic laboratory of the University.

4. *The second St. Petersburg period* (*1891–1905*). This began with research activities and ended in administrative work, the latter being largely responsible for his subsequent temporary retirement from both. The most important research problems of this period concerned the fixation of atmospheric nitrogen and the retting of flax. The work was done at the Institute of Experimental Medicine.

5. *The period of transition and rest* (*1905–1922*). These 17 years were spent by Winogradsky on his estates in the Ukraine, away from scientific work. As a result of political upheaval following World War I and the revolution, he was eventually forced to leave his native country forever. After a few months spent in Jugoslavia, he finally arrived at the Pasteur Institute in France.

6. *The active Brie-Comte-Robert period* (*1922–1940*), which signalized a return to scientific work. The problems considered were largely connected with the broad aspects of soil microbiology. This work was done in the Division of Agricultural Microbiology of the Pasteur Institute.

7. *The period of forced retirement* (*1940–1953*). During his retirement from active scientific work, he devoted himself to collecting all his papers and translating many of them. His collective work, under the title *Soil Microbiology; Problems and Methods. Fifty Years of Research*,[1] was published in 1949 by the Pasteur Institute in Paris.

Winogradsky was an accurate observer. Many of his early physiological studies, especially on the sulfur and iron bacteria, were made largely by the use of the microscope. His chemical methods were very simple. They always gave valuable results because they were invariably supplemented by careful and most painstaking observation. He always disliked "standard methods" and usually devised his own simple and direct methods for a particular problem. This happy combination of observation and experimentation resulted in his brilliant contributions to microbiology.

Winogradsky attacked some of the most difficult problems in the field of microbiology, and his name will be forever connected with certain phases of this young but rapidly growing science. His investigations dealt primarily with microorganisms of a highly specific physiology, which sets them apart from other microbes. These organisms were recognized as important agents in the cycle of life in nature—transforming such elements as nitrogen, sulfur, and iron in the soil, in the sea, and in sewage—as well as in a great variety of processes upon which the very life of plants and animals is based. Winogradsky was one of the few true pathfinders in microbiology. Among the various groups of bacteria he studied and with which his name has become primarily associated, none is more important and more specific than the group of autotrophic bacteria, with which he began his epoch-making work in bacteriology and which served as the subject for some of his more recent studies.

As a result of the brilliant investigations of Louis Pasteur, Ferdinand Cohn, and Robert Koch, bacteriology developed rapidly from a mere biological curiosity into a science of great practical importance, with numerous ramifications, stretching into the domains of medicine, agriculture, industry, and certain arts. Winogradsky's name is particularly associated with certain special branches of bacteriology, which he not only discovered but also developed to a high stage of perfection. These include, besides his studies on the autotrophic bacteria, his contributions to knowledge of the nonsymbiotic nitrogen-fixing bacteria, as well as his investigation on the oxidation of sulfur, the bacteriology of cellulose decomposition, and the microbiology of the soil. His work thus has proved to be the basis for a better understanding of the nature and physiology of various highly specialized and important groups of bacteria.

[1] *Microbiologie du Sol; Problèmes et Méthodes. Cinquante ans de Recherches.* Paris, Masson, 1949.

News and Notes

Second Conference on Medium Energy Nuclear Physics

About 137 physicists assembled at the Mellon Research Institute on June 4, 5, and 6 for the second Conference on Medium Energy Nuclear Physics sponsored by the University of Pittsburgh. The sessions were quite informal, with a relatively small number of papers and ample opportunity for discussions. The fact that no time limits were imposed either on the speakers or on the ensuing discussions helped to make this conference a worth-while and enjoyable experience for those attending.

In the course of the three-day program 18 papers were presented, dealing with beta decay, nuclear forces and capture gamma rays, photon-induced reactions, inelastic neutron scattering, a review of nuclear energy levels, and neutron-induced reactions.

In the first paper of the opening session, L. Langer (Indiana) indicated that all the experimental data on beta decay can be understood by a unique interaction involving a linear combination of scalar, tensor, and pseudoscalar interactions. The last term is included to explain the unusual case of RaE. On the other hand, the next speaker, M. E. Rose (Oak Ridge), cautioned that perhaps more experimental evidence is needed before a final decision for a unique beta interaction can be made. He discussed some possible experiments which might decide between different interaction terms and also would give information about the occurrence of the so-called Fierz interference terms between scalar and tensor interactions. A quite different problem was the subject of the closing paper of this morning session presented by H. Primakoff (Washington, St. Louis), concerning double beta decay. After a review of the experimental data, he pointed out that more accurate experiments must be performed in order to make a choice between the two theories proposed for double beta decay, one assuming no emission of a neutrino, the other involving the emission of two neutrinos. He also mentioned that precise measurements of the energy distribution from μ meson decay would throw some light on this problem.

The afternoon session was opened with a paper by I. Talmi (Princeton) on the angular momenta and parities of excited states of even-even nuclei. Theoretical arguments, based on the independent particle model of nuclear structure, make plausible the empirical rule for even-even nuclei that states of odd augular momentum have odd parity and those with even angular momentum have even parity. E. Gerjuoy (Pittsburgh) presented a critical discussion of the Butler theory of stripping reactions and examined the agreement of this theory with experimental data. The last two speakers in this session reported investigations at Chalk River on the gamma radiation emitted in nuclear capture processes. The measurement of relative intensities of gamma transitions resulting from proton capture was discussed by E. B. Paul, while similar measurements for the neutron capture process were presented by G. Bartholomew. A comparison of the relative gamma transition probabilities with the Weisskopf formula, based on the independent particle model, showed good agreement if the complexity of the nuclear states is taken into account. Electric dipole transitions, however, appear to be somewhat slower than predicted by the theory.

The morning session of the second day was devoted to photon-induced reactions. The application of isotopic spin selection rules to gamma-alpha reactions was discussed by V. Telegdi (Chicago). The satisfactory agreement between the theory of Gell-Mann and Telegdi and the experimental data on the C^{12} (γ, 3α) and O^{16} (γ, 4α) reactions lend support to the assumption of isotopic spin selection rules. The determination of excitation functions for photon-induced reactions by using the continuous x-ray spectrum of a betatron was described by L. Katz (Saskatchewan). With careful regulation of the betatron energy the Saskatchewan group has observed breaks in the excitation curves which are interpreted as being due to nuclear level structure.

The first three papers of the fourth session were devoted to the determination of cross sections of inelastic scattering of neutrons. J. Beyster described the experimental arrangement at Los Alamos for measuring the inelastic scattering cross sections of fission neutrons for a number of elements. To reduce the influence of elastic scattering, the scattering material was used in the form of a spherical shell surrounding the detector. The theory pertinent to this arrangement was presented by H. Bethe (Cornell), who also reported the results. These show that the cross sections vary approximately as $A^{2/3}$, except for the "magic nuclei." T. Bonner (Rice) spoke of similar investigations using monoenergetic neutrons from the *d-d* and *d-t* reactions. R. Hellens (Westinghouse) gave preliminary results of photographic plate determinations of energies of neutrons scattered from iron. Concluding the afternoon session, an up-to-date compilation of all known energy levels of light nuclei was very clearly presented by F. Ajzenberg (MIT). The level diagrams were arranged in such a manner as to emphasize the implications of charge symmetry and charge independence of nuclear forces.

H. Feshbach (MIT) opened the final session with a discussion of the magnitude of the nuclear radius based upon electron scattering measurements. Such experiments appear to indicate a value some 20% smaller than that derived from experiments involving only nuclear particles. No explanation for this discrepancy is known. In the second talk, H. Barschall gave an account of the excellent work at Wisconsin on neutron scattering. Total neutron cross sections

have been measured as a function of energy E from 1 to 3 Mev for over 50 nuclei of different A. The data, presented in a three-dimensional plot, showed a smooth variation with E and A, with several characteristic hills and dales. That all the features of these variations can be derived from a simple theory was demonstrated by V. Weisskopf (MIT) in the next talk. This theory assumes that the nucleus is represented by a square well potential including an imaginary term which gives rise to an absorption of the incident neutron wave (a so-called gray crystal ball). The limitations of this theory were carefully pointed out by the speaker and certain modifications suggested. After a brief summary of inelastic scattering experiments with monoenergetic neutrons, C. Goodman (MIT) reported on some preliminary experiments which indicate the possibility of excitation of low-lying levels of heavy nuclei (Ta, Pt) by low-energy protons (1.5 Mev).

In addition to the program, visitors were cordially welcomed to the laboratories of both the University of Pittsburgh and the Carnegie Institute of Technology. The social gatherings in the evenings and the picnic at the Saxonburg site of the Carnegie synchrocyclotron were certainly appreciated by all participants of the conference.

R. O. Haxby
R. M. Steffen
D. J. Tendam

Department of Physics
Purdue University

Scientists in the News

Spencer R. Atkinson, Head of the Department of Graduate Orthodontics in the University of Southern California School of Dentistry, has been awarded the Albert H. Ketcham Memorial Award, the highest honor in the field of orthodontics, given by the American Board of Orthodontics with the approval of the American Association of Orthodontists. Dr. Atkinson was a pioneer in the development of dentistry for children. Next to his Pasadena residence he has built a modern and well-equipped laboratory for anthropological research in orthodontics. The laboratory collection contains more than 1000 human skulls, about 400 with normal "bite" and the majority with teeth free of cavities. Virtually every dental deformity is represented in the others. About 1500 upper and lower jaws of children from 17 different countries are included in the collection. Dr. Atkinson has also been decorated by the Mexican government with the Double Aztec Eagle, Insignia Grade, for his work in advancing dental education in Mexico.

Sanford S. Atwood, Head of the Department of Plant Breeding at Cornell University, has been appointed Dean of the Graduate School. Commencing July 1, he will serve a 5-year term. He will continue for the time being as Head of the Department of Plant Breeding. A member of the Cornell faculty since 1944, Professor Atwood is widely known for his work in improving forage crops.

George Granger Brown, Dean of the College of Engineering at the University of Michigan, has been appointed Treasurer of the American Institute of Chemical Engineers to fill out the term of C. R. DeLong, Vice President of North American Solvay and the Solvay American Corporation, who resigned after serving since 1936. Dr. Brown is a former President of A.I.Ch.E.

Merrill M. Flood, formerly with the Rand Corporation in Santa Monica, has accepted an appointment as Professor of Industrial Engineering at Columbia University.

Paul D. Foote, Executive Vice President of the Gulf Research and Development Company and Past President of the American Physical Society, was awarded in June an Honorary Doctor of Science degree from Carnegie Institute of Technology, the eighth to be given in the school's 53-year history.

Joseph K. Hill, lecturer in education and public health at Yale University, will join the staff of the State University of N. Y. College of Medicine as Assistant Professor of Public Health and Preventive Medicine.

In August a delegation of some 80 American home economists under the leadership of **Mildred Horton,** Executive Secretary of the American Home Economics Association, will attend the Eighth International Congress on Home Economics in Edinburgh, Scotland. The aim of this international federation is to encourage the development of home economics in every country, with the cooperation of the public authorities and of educational, scientific, and professional organizations.

Dwight J. Ingle, Research Physiologist at the Upjohn Company, has been appointed Professor of Physiology in the Ben May Laboratory for Cancer Research at the University of Chicago, effective September 1.

To honor outstanding engineering achievement in the field of agriculture, the American Society of Agricultural Engineers awarded the John Deere Gold Medal to **Orsen W. Israelsen** of Utah State Agricultural College, Logan, Utah, and the Cyrus Hall McCormick Gold Medal to **Andrew A. Potter,** Dean of the Engineering Schools at Purdue University, Lafayette, Ind.

Joseph M. Kirshner has joined the staff of the Ordnance Electronics Division of the National Bureau of Standards, Washington. A specialist in solid state physics and gas discharge phenomena, Dr. Kirshner will be engaged in investigations of the theoretical aspects of guided missile fusing. Since 1948 Dr. Kirshner has been associated with the Naval Research

Laboratory, Washington, where he conducted research on photoconductivity and on the behavior of electrons in gases.

Paul Meeks has resigned as chief of the guided missile engineering division of the California Institute of Technology's Jet Propulsion Laboratory in Pasadena, where he has been stationed for more than 10 years, to head a new development and manufacturing program for guided missile instruments at the Clary Multiplier Corporation, San Gabriel.

Edward G. Spencer has joined the staff of the Ordnance Electronics Division of the National Bureau of Standards. A specialist in microwave spectroscopy and magnetic resonance, he came to the NBS from the Naval Research Laboratory, Washington, D.C., where he was investigating paramagnetic and nuclear resonance of solids.

Harlow L. Walster, who retired July 1 after 34 years on the North Dakota Agricultural College faculty, received the sole honorary degree granted by the institution this year. Dr. Walster joined N.D.A.C. as an agronomist in 1919, was appointed Dean of the School of Agriculture in 1924, and in 1934 became Director of the North Dakota Experiment Station. He also organized the Flax Institute of the United States two decades ago and was its president for 20 years, until retiring a few months ago.

Grants and Fellowships

Authors of outstanding technical papers presented at previous meetings of the **American Society for Testing Materials** received awards at the 56th Annual Meeting of ASTM in Atlantic City during the week of June 29, as follows: to Evan A. Davis and Michael J. Manjoine, Research Engineers, Westinghouse Research Labs., for their paper "Effect of Notch Geometry on Rupture Strength at Elevated Temperatures," the *Charles B. Dudley Medal*; to William N. Findley and P. G. Jones, Theoretical and Applied Mechanics Dept., University of Illinois, Robert L. Sutherland, Mechanical Engineering Dept., State University of Iowa, and W. I. Mitchell, South Dakota School of Mines, for their paper "Fatigue Machines for Low Temperatures and for Miniature Specimens," the *Richard L. Templin Award*; to Katherine Mather, Corps of Engineers, Jackson, Miss., for "Applications of Light Microscopy in Concrete Research," the *Sanford E. Thompson Award*; to J. R. McDowell, Westinghouse Research Labs., for "Fretting Corrosion Tendencies of Several Combinations of Materials," the *Sam Tour Award*. All papers were read at the 1952 50th Anniversary Meeting.

Cornell University is the recipient of a three-year grant of $260,000 from the **Ford Foundation,** for support of their program of Indian studies, for the creation of fellowships for the study of India and Indian problems, and for field research in India. Morris E. Opler will direct the program. A team of Cornell social scientists and technicians will carry on research in the field in connection with the community development enterprises which has been developed in rural India under the auspices of the Indian Government, the Ford Foundation, and Point IV-TCA. They will cooperate in research being carried on to evaluate results and measure progress, and to assess long range implications. The project is a part of studies in culture and applied social science that began in 1948.

Eli Lilly and Company has recently renewed a grant to the University of California to support the work of Saul Winstein on fundamental projects in organic chemistry.

Howard H. Hillemann of the Department of Zoology, Oregon State College, has been awarded a **U. S. Public Health Service** grant of $13,589 to support a comparative study on the placenta of primates other than man, including cyto- and histochemical studies of tissues. The grant is to cover a 3-year period.

Meetings and Elections

The 11th Annual Meeting of the **Electron Microscope Society of America** will be held at the Pocono Manor Inn, Pocono Manor, Pa., Nov. 5–7. Programs with abstracts of papers to be presented will be available Oct. 15 from A. R. T. Denues, Program Chairman, Sloan-Kettering Institute for Cancer Research, 444 E. 68th St., N. Y. 21, N. Y. Local arrangements are being handled by Kenneth S. McCarty, Veterans Administration, 130 W. Kingsbridge Rd., Bronx, N. Y.

At the 52nd Annual Meeting of the **Medical Library Association** the following officers were elected: president, Marion Dondale, Albany, N. Y.; vice president (president-elect), Wilma Troxel, Chicago, Ill.; honorary vice president, Louis S. Goodman, Salt Lake City, Utah; secretary, Audrey L. Kargus, St. Louis, Mo.; treasurer, R. A. Schlueter, Oak Ridge, Tenn. The Board of Directors includes William D. Postell, New Orleans, La. (immediate past president); Bertha B. Hallan, Portland, Ore.; and J. Alan MacWatt, Pearl River, N. Y. Mildred R. Crowe, Birmingham, Alabama will serve as chairman of the Nominating Committee.

The 16th Meeting of the **Meteoritical Society** will be held Sept. 2–4 in the Randall Physics Laboratory of the University of Pennsylvania on its Philadelphia campus. The general sessions will be open to the public, and members of the American Meteor Society are particularly invited to attend.

The newly organized **Southwestern Association of Naturalists** has elected the following officers: president, W. Frank Blair, University of Texas; vice president, George Goodman, University of Oklahoma; secretary-treasurer, Herndon Dowling, University of

Arkansas; editor, George M. Sutton, University of Oklahoma. The Association will promote field studies and distribute information about Southwestern plants and animals, and any interested person is invited to join.

An international conference on **Upper Atmosphere Research** is to be held at Oxford University, England, Aug. 24–26. Research will be presented by American, British, and European scientists, and arrangements for the meeting are under the direction of the Royal Society's Gassiot committee, led by H. S. W. Massey, University of London physicist. James Van Allen, Head of the Physics Department and rocket research specialist at the State University of Iowa, is coorganizer of the conference and is in charge of the U. S. delegation. He has been since 1948 Chairman of the national Upper Atmospheric Research panel, which is coordinating the research reporting of American institutions and organizations active in upper atmospheric research.

Miscellaneous

The editor of an American journal has received the following letter from a Russian member of his editorial board. Because it is singularly revealing of the state of affairs in Russian science, the letter is printed below, but without those identifying names that might lead to reprisals upon the writer.—EDITOR.

I received your letter of the second of September, 1952, and in accordance with your request I am writing to inform you that I am continuing my work at . . . and up to now have been receiving your journal . . . quite regularly.

For my part I want to ask you the following:

For nearly 20 years I have been a member of the editorial board of . . ., and throughout that time I have contributed nothing in this capacity.

A similar situation in regard to my participation in the work of the editorial staff will continue if I remain a member. In connection with this, I am asking you to remove my name from the editorial board and at the same time stop sending me your journal.

I am asking you not to send me the journal . . ., not only because I am resigning from the editorial staff, but also because in recent years there have been published in your journal papers and reviews which, according to their ideological content, do not correspond to my own convictions and point of view and therefore I do not care to carry any responsibility for them.

The most powerful electric motors known to have been built have been installed at the **Arnold Engineering Development Center,** Tullahoma, Tennessee. The motors are as high as a two-story house, and their installation is the first major step in the assembly of what is believed to be the world's largest rotating machine. The two motors, rated at 83,000 horsepower each, and a smaller pair, rated at 25,000 horsepower each, will produce a total of 216,000 horsepower to drive five huge compressors which will produce man-made hurricanes for transonic and supersonic wind tunnels of the Propulsion Wind Tunnel Facility at the Center. This Center is the newest of the nine research, development, and testing Centers of the Air Force's Air Research and Development Command, and will provide the means for testing and evaluating supersonic aircraft, guided missiles, and aircraft engines.

Geological Survey topographic mapping parties have started operations in the 1953 Alaskan mapping program. Work is scheduled in two general areas. One covers approximately 17,000 square miles in the Kantishna River, Melozitna, Tanana, Fairbanks, Healy, and Mt. McKinley areas. This is to be all new mapping at a scale of 1:63,360. The other area will cover approximately 68 additional "inch-to-the-mile" quadrangles in the Seward, Kenai, Tyonek, Blying Sound, and Seldovia areas. The latter operations will be in the nature of "field completion," to check the cultural data contained on maps almost ready for publication. Mapping in Alaska is a cooperative effort with the U. S. Air Force and the Navy photographing the territory from the air for all photogrammetry accomplished by the Survey and the Corps of Engineers. Electronic aids have also been used to cut costs and speed operations. This summer it is planned to use two helicopters for the reconnaissance and transportation necessary to establish basic and supplemental control in the area of the new mapping. One helicopter party will be under the direction of party chief Leo H. Hendrickson, assisted by I. J. Benes, A. J. Kordziel and E. E. McClelland; the other helicopter party will be directed by party chief M. A. Harmel, assisted by I. B. Johnson, L. J. Roberts, and T. E. Taylor. The field completion work in the vicinity of Seward and Kenai will be accomplished by party chief R. L. Longworth. Maps of the Reconnaissance Series may be purchased for 25 cents each and those of the 1:63,360 series at 20 cents each, from the Chief of Distribution, Geological Survey, Washington 25, D. C. An index map showing the areas in Alaska covered by Survey mapping is available free.

Following a request from the Secretary of Commerce that the National Academy of Sciences appraise the quality of the work performed by the **National Bureau of Standards** in relation to the battery additive AD-X2, the Academy has appointed the following scientists to constitute a committee for that purpose: Zay Jeffries, Chairman, retired Vice President in charge of Chemical Department, General Electric Company; E. K. Bolton, retired Director of Chemical Department, E. I. du Pont de Nemours and Co.; William G. Cochran, Professor of Biostatistics, Johns Hopkins University; John G. Kirkwood, Professor of Chemistry, Yale University; Victor K. La Mer, Professor of Chemistry, Columbia University; L. G. Longsworth, Member, Rockefeller Institute; Joseph E. Mayer, Professor of Chemistry, University of Chicago; John C. Warner, President, Carnegie Institute of Technology.

"The Healing Art of Old New York," a special exhibition arranged in connection with the New York

meetings of the American Medical Association, opened at the **New York Historical Society** on June 2nd. Covering the period of the last 150 years, the exhibit is composed of portraits and engravings of prominent physicians, doctoral theses, medical tracts, illustrations of early hospital buildings, and items of medical equipment from Revolutionary and Civil War times. Century-old manuscripts, books, and doctors' bills provide an interesting contrast to modern medical methods. The display will be continued through Nov. 15.

The U. S. Public Health Service's new Clinical Center at Bethesda was formally dedicated on July 2 by Oveta Culp Hobby, Secretary of the Department of Health, Education, and Welfare. Marking the culmination of more than 5 years of planning and construction, the dedication inaugurated use of the new 500-bed Center which is designed to strengthen the Public Health Service's efforts to solve the problems of cancer, mental illness, arthritis, heart disease, and other long-term illnesses under research programs conducted by the National Institutes of Health at Bethesda.

Recent Deaths

Eugene Antrim (79); educator and university president, Crescent, Okla., June 4; **John B. Appleton** (62), geographer, Bethesda, Md., June 24; **Ralph Bailey** (79), analytical chemist, Westfield, N. J., June 11; **Paul H. Belding** (56), dentist and editor, Waucoma, Iowa, June 3; **Dmitri Belyankin** (76), Russian geologist, Moscow, June 21; **William Braunstein** (53), pathologist, Weehawken, N. J., June 23; **John J. Breslawsky** (75), mathematician and engineer, Passaic, N. J., June 13; **Robert H. Briggs** (55), industrialist and chemist, Bronxville, N. Y., June 2; **Harry W. Cave** (63), agriculturalist, Stillwater, Okla., June 23; **Louis M. Chokla** (74), civil engineer, East Rockaway, L. I., N. Y., June 1; **Al D. Crowley** (55), chemical engineer, Union, N. J., June 6; **Thomas H. Curtin**, eye-specialist, lecturer and writer, New York, N. Y., June 3; **Benjamin M. Davis** (?), physiologist, Oxford, Ohio, June 18; **Tihamer I. De Fabinyi** (62), economist, Boston, Mass., June 10; **Charles C. Deam** (87), botanist and conservationist, Bluffton, Ind., May 29; **George L. Diggles** (65), laboratory director and electrical engineer, Greenport, L. I., N. Y., June 17; **Theodore Ferris** (80), naval architect and marine engineer, Wallington, N. J., May 30; **Walter S. Finlay, Jr.** (70), mechanical engineer, New Rochelle, N. Y., June 17; **Alma M. Frank** (55), child psychologist, New York, N. Y., June 1; **E. D. Friedman** (68), neurologist, New York, N. Y., June 7; **Irving I. Gellman** (63), chief medical officer, veterans' hospital (Huntington, W. Va.), Queens, N. Y., June 14; **Walter Goldfarb** (43), psychiatrist, New York, N. Y., June 5; **Edwin Graham** (89), pediatrician, Madison, Va., June 10; **Joseph R. Gray, Jr.**, (83), bacteriologist and pathologist, Upland, Pa., June 9.

Robert M. Haig (65), political economist, New York, N. Y., June 9; **Daniel Hanson** (61), British metallurgist, Haselor, England, June 12; **Frank R. Henderson** (60), pharmacist and Sharp and Dohme government representative, Philadelphia, Pa., May 30; **W. Oakley Hermance** (80), medical professor, Philadelphia, Pa., June 12; **William Holman** (74), bacteriologist, Toronto, Canada, June 22; **George W. Humpfer** (63), electrical engineer, Philadelphia, Pa., June 10; **Albert F. Hutchinson** (60), safety engineer and chemist, Plainfield, N. J., June 11; **Albert E. Jenks** (83), anthropologist, Minneapolis, Minn., June 6; **Louis A. Klein** (82), dean and professor of veterinary medicine, Philadelphia, Pa., June 22; **Edwin P. Kolb** (69), tuberculosis specialist, Patchogue, L. I., N. Y., June 14; **Milton Kutz** (69), electro-chemist, Wilmington, Del., June 16; **Murray A. Last** (52), eye surgeon, New York, N. Y., June 25; **David Lieberthal** (86), consulting dermatologist, Chicago, Ill., June 10; **Ralph K. Logan** (54), metallurgist and industrialist, Cleveland, Ohio, May 29; **Harry McCormack** (76), chemical engineer and professor, Chicago, Ill., June 8; **William L. Mann, Jr.** (68), head of Naval Medical Research Institute (Bethesda), Washington, D. C., June 12; **Dan O. Mason** (61), chemist and safety engineer, Highland Park, N. J., June 11; **Aristotle D. Michal** (54), mathematician, Pasadena, Calif., June 14; **Ellis H. Minns** (78), British archaeologist, Cambridge, England, June 14.

Oscar Norgorden (44), of Washington, D. C., electronic scientist, Hokkaido, Japan, May 29; **John W. Nuzum** (62), cancer specialist, Chicago, Ill., June 14; **Leland B. Norton** (43), entomologist, Ithaca, N. Y., June 11; **Joseph G. Parker** (29), surgeon, USPHS, New York, N. Y., June 21; **Earle B. Phelps** (76), chemical biologist and public health specialist, Gainesville, Fla., May 29; **Martin L. Reymert** (69), psychologist and director of child research, Mooseheart, Ill., June 2; **Geza Roheim** (61), anthropologist and psychoanalyst, New York, N. Y., June 7; **Edward Schaub** (71), of Chicago, Ill., philosopher, Durham, N. C., May 24; **Robert C. Schott** (62), electrical engineer, New York, N. Y., June 12; **Geddes Smith** (63), executive associate of Commonwealth Fund, New York, N. Y., June 16; **Ferdinand Sonneborn** (79), chemist, and industrialist, New York, N. Y., June 9; **D. A. Steele** (59), mathematician, New York, N. Y., June 18; **Earle Strain** (87), pathologist, Great Falls, Montana, June 2; **Cyril Tasker** (54), director of heating and ventilating research, Warren, Ohio, June 24; **David Turnoff** (41), specialist in internal medicine, Philadelphia, Pa., June 14; **Alexander A. Vasiliev** (85), historian, Washington, D. C., May 30; **Perley C. Voter** (64), chemist and professor, Middlebury, Vt., June 12; **Stephen H. Watts** (75), professor of surgery, Charlottesville, Va., June 7; **Mary Willcox** (97), zoologist, Pocasset, Mass., June 5; **P. D. R. Williams-Hunt** (31), museum curator, Kuala Lumpur, Malay, June 12; **Erle F. Young** (64), sociologist, Modesto, California, May 31.

Technical Papers

Biosynthesis of Penicillin. I. Role of Phenylacetic Acid

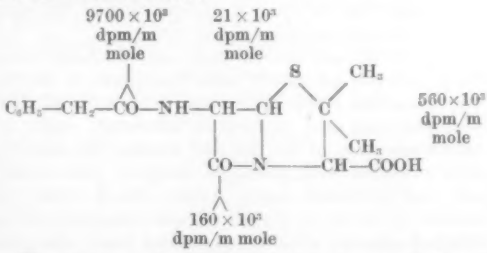
Maxwell Gordon, S. C. Pan, Angelo Virgona, and Paul Numerof

Squibb Institute for Medical Research, New Brunswick

In view of the long period that penicillin has been under investigation it is somewhat surprising that comparatively little is known about the biosynthesis of this antibiotic. The only tracer studies that have come to our attention are those utilizing deuterophenylacetyl-N^{15}-valine (*1*), phenylacetic acid-1-C^{13} (*2*), and S^{35} (*3*). The apparently clear-cut results obtained in the incorporation of the benzyl residue from phenylacetic acid into benzylpenicillin have perhaps discouraged further investigations with this precursor.

Behrens *et al.* (*1*) found that 92.5% of the benzylpenicillin obtained was derived from the deuterium-labeled phenylacetic acid. Craig *et al.* (*2*) similarly found excellent incorporation of phenylacetic acid-1-C^{13} into benzylpenicillin, although quantitative data are not given.

We have studied the incorporation of phenylacetic acid-1-C^{14} into benzylpenicillin by *Penicillium chrysogenum* Wis 49-133 and have found that the specific activity of the phenylacetic acid isolated by chemical degradation of the penicillin (*4*) was about 82% of the activity of the precursor phenylacetic acid. Decarboxylation (*5*) of the phenylacetic acid isolated by hydrolysis of the penicillin showed all of the radioactivity to be in the carboxyl group. We have also investigated other major fragments of the penicillin molecule by chemical degradation (*4*) and the results are summarized below:



The starting phenylacetic acid had an activity of $11{,}500 \times 10^3$ disintegrations/min/m mole. The specific activity of the penicillin was approximately $12{,}000 \times 10^3$ disintegrations/min/m mole. All activity values have a standard deviation of 5% or less, except for the figure given for the glycine moiety (21×10^3) which has an S.D. of about 10%.

A rough correspondence has been observed between the average specific activity of the respiratory CO_2 from the fungus and that of the CO_2 from the β-lactam carbonyl, and this similarity points to the possibility of CO_2 fixation playing a role in penicillin biosynthesis (*6*). These results are apparently not in agreement with those of Godzesky, Martin, and Stone (*7*), who report no significant fixation of $C^{14}O_2$ from bicarbonate into the penicillin molecule by *P. chrysogenum* (Q-176). Work on determination of the individual specific activities of all the carbons in this biosynthetic penicillin is in progress. Fermentation details will be described separately.

References

1. Behrens, O. K., Corse, J., Jones, R. C., Kleiderer, E. C., Seper, Q. F. Van Abele, F. R., Larson, L. M., Sylvester, J. C. Haines, W. J., and Carter, H. E. *J. Biol. Chem.*, **175**, 765 (1948).
2. Craig, J. T., Tindall, J. B., and Senkus, M. *Anal. Chem.*, **23**, 332 (1951).
3. (a) Few, A. V., Cooper, P. D., and Rowley, D. *Nature*, **169**, 283 (1952).
   (b) Rowlands, S. Rowley, D., and Smith, L. *J. Chem. Soc.*, S-405 (1949).
   (c) Howell, S. F., Thayer, J. D., and Labaw, L. W. *Science*, **107**, 299 (1948).
4. Clarke, H. T., *et al. The Chemistry of Penicillin.* Princeton: Princeton Univ. Press, 64–68 (1949).
5. Dauben, W. G., and Goad, P. *J. Am. Chem. Soc.*, **71**, 2928 (1949).
6. Gitterman, C. O., and Knight, S. A. *J. Bact.*, **64**, 223–31 (1952).
7. Godzesky, C. S., Martin, E. L., and Stone, R. W. *Bact. Proc.*, 162 (1952).

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The Reaction Occurring in CO_2–H_2O Mixtures in a High-Frequency Electric Arc[1]

Kenneth A. Wilde, Bruno J. Zwolinski, and Ransom B. Parlin

Department of Chemistry, University of Utah, Salt Lake City

This study was initiated in the hope of isolating 1, and possibly 2, carbon-atom compounds formed by the reduction of carbon dioxide by water vapor in a high-frequency arc. It forms a part of a series of studies of the chemical effects of high-frequency discharges on gaseous systems. The action of radiation on these 2 gases is of special interest in relation to the basic photosynthetic process, and also carries implications with respect to the origin of living matter on earth. A typical flow system was employed, with an army aircraft 150-w transmitter supplying the necessary power to the discharge tube.

Exhaustive examination has failed, however, to definitely establish the presence of any interesting reduction products in a reproducible way. Most of the parameters affecting the process were investigated, including current, pressure, flow rate, and H_2O/CO_2

[1] This work is supported by the Atomic Energy Commission under Contract AT(11-1)-82.

ratio, but without definitive results. The ranges of these variables are given in Table 1.

TABLE 1

Variable	Range
Flow rate	5–35 cc/sec (STP)
Pressure	50–250 mm Hg
Current	75–200 ma
Composition	3–25% H_2O by volume
Voltage	500–600 v
Gap distance	5 mm
Frequency	3 mc
Electrodes	Copper and Inconel

The following methods of analysis were employed:

1. Infrared spectra of the product gases were examined in the range of wavelengths of 2.5–15 μ with a Perkin-Elmer model 12C automatic-recording spectrophotometer. The only compounds having absorption bands in the above region which could be definitely identified were CO_2, H_2O, and CO.

2. To meet with the sensitivity of the chemical tests employed in detecting the products of the irradiation, the duration of runs was increased from 4–90 min. The exit gases from the discharge tube were thoroughly scrubbed in liquid-water traps. Since all of the likely products (formaldehyde, formic acid, carbon suboxide, glyoxal, etc.) are soluble in water, this method should collect nearly all of the products of interest. In general, no positive tests were obtained with, e.g., dilute permanganate, modified Schiff's reagent (for formaldehyde [*1*]) and dimethyldihydroresorcinol (*2*), a standard reagent for formaldehyde. Tests for formic acid and methyl alcohol (*3*) also gave negative results. Occasionally the ice from the dry ice-acetone trap or washings from the walls of the discharge tube decolorized permanganate solution but still gave no specific compound tests. In an effort to recover monomers from possible polymeric products present, several samples were made basic and digested to depolymerize any substances such as paraformaldehyde. Again, no positive results were obtained.

3. The product gases were passed through 1% sodium bisulfite solution according to the procedure of Goldman and Yagoda (*4*) for estimation of traces of formaldehyde in air. The excess bisulfite is titrated with 0.1 *N* iodine solution in acid medium. This solution is made basic with Na_2CO_3–acetic acid buffer and the formaldehyde liberated from the bisulfite complex is titrated with 0.01 *N* iodine solution. Sensitivity of the order of 7 parts (by wt) per million is claimed in this method. No formaldehyde could be detected, however.

In summary, it appears that under the conditions employed, no interesting reduction products of the carbon dioxide–water reaction are formed, at least in quantities greater than 10 ppm. Traces of the usual matter found in discharges tubes—solid polymers of unknown composition—may be formed, however.

The reason for the nonappearance of reduction products in chemically significant quantities is not clear. The decomposition of CO_2 to CO took place to the extent of about 9%, and it is known (*5*) that CO and hydrogen atoms (produced from H_2O) react in discharge tubes to give formaldehyde. Either there was an insufficient supply of hydrogen atoms, or any product formed was decomposed thermally in the region of the arc plasma itself or at the electrodes.

References

1. WALKER, J. F. *Formaldehyde.* New York: Reinhold, 245 (1944).
2. ———, p. 252.
3. FEIGL, F. *Manual of Spot Tests.* New York: Academic Press, 193 *et seq.* (1943).
4. GOLDMAN, F. H., and YAGODA, H. *Ind. Eng. Chem., Anal. Ed.*, **15**, 377 (1943).
5. CARESS, A., and RIDEAL, E. K. *Proc. Royal Soc. London*, **120A**, 470 (1928).

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Susceptibility of *Rattus hawaiiensis* Stone to Warfarin

David D. Bonnet and Bertram Gross

Division of Sanitation, Department of Health, Territory of Hawaii, Honolulu

Previous cage tests (*1*, *2*) have shown that warfarin-treated rolled oats were readily accepted by the five rodent species, *Rattus norvegicus* (Erxleben), *Rattus alexandrinus* (Geoffrey), *Rattus rattus* Linn., *Rattus hawaiiensis* Stone, and *Mus musculus* Linn. present in the Territory of Hawaii and that all these species died from the effects of the poison.

Field tests reported by Doty (*1*) showed that warfarin-treated oats gave good control of rats damaging sugar cane, and he suggested that for satisfactory results the warfarin bait should be exposed for at least 17 days or until the consumption of bait reached zero.

Gross, Baker, and Bonnet (*3*) in a large scale field test in an endemic plague region in Hawaii, have shown that all species of rodents were adequately controlled with the same bait formula except the local endemic species, *Rattus hawaiiensis*. The importance of this species in the epidemiology of rodent plague in the Territory of Hawaii (*4*) indicated the desirability of investigating further the susceptibility of this species to warfarin-poisoned rolled oats.

A series of cage feeding tests was instituted after the procedures previously used. Specimens of *Rattus norvegicus* and *Rattus hawaiiensis* were captured alive near Honolulu and confined in laboratory cages. A record was kept of the sex and weight. The animals were provided with pieces of coconut, plain rolled oats, and unlimited water. After a short period of adaptation to the cages each rat was presented with a weighed quantity of warfarin-treated oats.[1] The poisoned oats were removed and replaced with unpoisoned rolled oats every other day. The amount of food or bait eaten was determined by daily weighing of the food dish and its contents. The warfarin bait was regularly accepted and there was no evidence of consistent bait refusal or avoidance during the test. This

[1] A commercial product prepared according to the formula of Doty (*1*) and containing by weight 0.025% warfarin, 11.0% white mineral oil, 0.25% p-nitrophenol (a mold deterrent) and 88.73% rolled oats. This is identical with the warfarin bait used in previous tests (*1–3*).

TABLE 1

	R. hawaiiensis	*R. norvegicus*
Number of animals	20	10
Mean weight of test animals	48.0 ± 1.8 g	186.7 ± 14.7 g
Number surviving 34 days of alternate feeding	15	0
Minimum day of death	7 days	4 days
Maximum day of death	34 days	11 days

regimen was continued until the animal died or 34 days of alternate exposure to warfarin-treated oats and plain rolled oats had occurred.

The results obtained are presented in Table 1.

The alternate feeding of warfarin oats and plain oats to *Rattus norvegicus* gave a kill identical to the results obtained by Doty (*1*) with continuous feeding of the same poison bait mixture. All individuals died in 11 days or less and showed evidence of internal hemorrhages on autopsy. On the other hand, with *R. hawaiiensis*, 75% of the test individuals survived more than 34 days of this alternate feeding of warfarin-poisoned oats and plain rolled oats. This period is double the 17-day period of feeding recommended by Doty as a practical time limit for field poisoning. The average consumption of poison bait during the 34-day period was approximately twice the average amount that had been previously found to kill this species when consumed on a daily basis (*2*). These data indicate that unsatisfactory results will be obtained in the case of *R. hawaiiensis* unless the present warfarin bait is consumed at a frequency greater than every other day. Very little is known of the feeding habits of *R. hawaiiensis* in its native habitat, but the results obtained in the field test (*3*), in the light of the present data, would seem to indicate that in spite of a heavy consumption of the bait in the field, individual *R. hawaiiensis* probably did not consume the bait consistently on a daily basis, and hence survived the poisonous effects of the warfarin.

The fifteen *Rattus hawaiiensis* individuals that survived 34 days of alternate feeding and poisoning were placed on a continuous diet of warfarin oats bait on the 35th day. They all died as a result of warfarin poisoning, and the mean day of death was 13.5 ± 0.9 days after the beginning of this continuous period of warfarin feeding.

TABLE 2

	R. hawaiiensis Present experiment	*R. hawaiiensis* Previous experiment (*2*)
No. of individuals	15	42
Previous exposure to warfarin	Every other day for 34 days	None
Total body weight	959.3 g	2313.8 g
Mean body weight	49.6 ± 1.7 g*	55.1 ± 1.2 g
Total warfarin oats consumed	373.5 g	899.0 g
Total warfarin oats % of total body weight	38.9 ± 2.0%	38.9 ± 1.3%
Mean day of death	13.5 ± 0.9	7.9 ± 0.5

* The lesser weight of the animals of this series is due to an overall weight loss during the 34-day exposure period. The initial weight of this group was 52.0 ± 2.5 g.

The results obtained in this test are compared in Table 2 with the results obtained in the test already reported (*2*) on animals which had no previous exposure to warfarin.

Although the quantity of warfarin oats bait consumed in terms of percentage of body weight is the same in both series (38.9%), the mean number of days elapsing before death is significantly greater in the series previously exposed to warfarin bait on an alternate day basis. The physiological basis of this finding has not been determined but it is a possibility that the test animals had no avidity for food as a result of the probable sublethal poisoning over the 34-day period and hence took a longer time to consume the quantity of warfarin oats necessary to kill.

References

1. Doty, R. E. *Hawaiian Planters' Record*, **54**, (1), 1 (1950).
2. Bonnet, D. D., Mau, E. S. C., and Gross, B. *Public Health Repts. (U.S.)*, **66**, 1734 (1951).
3. Gross, B., Baker, R. H., and Bonnet, D. D. *Ibid.*, 1727.
4. Eskey, C. R. *Public Health Bull.*, No. 213, 1 (1934).

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Synthesis of DDT Labeled with Carbon-14 in the Tertiary Position

George W. Pearce and Jens A. Jensen

Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia

A method has been developed for the synthesis of radioactive Dichlorodiphenyltrichloroethane (DDT) in good yield in which the tertiary carbon is labeled.

Fields *et al.* (*1*) have developed a satisfactory procedure for incorporating C^{14} in the benzene ring. This procedure presumably was employed in a previously reported labeling of DDT with C^{14} (*2*). However, the complete synthesis of DDT by this procedure would involve at least seven major steps, with the consequent tendency towards low over-all yields. In the authors' procedure, only four major steps are necessary. Schematically, they are as follows:

$$BaC^*O_3 \longrightarrow CH_3C^*OOEt \xrightarrow{LiAlH_4} CH_3C^*H_2OH$$

$$\xrightarrow{Cl_2} CCl_3C^*HO \longrightarrow DDT \quad (\text{with } -Cl)$$

The synthesis of carboxy-labeled ethyl acetate was carried out by special adaptations of the methods of Sakami *et al.* (*3*), Van Bruggen *et al.* (*4*), and Ropp (*5*). The ester was reduced to ethyl alcohol by a modification of the method of Cox and Turner (*6*). Chlorination was carried out in a specially designed apparatus,

and the subsequent condensation of chloral with chlorobenzene followed the work of Mosher *et al.* (*7*).

Starting with 50 mM of barium carbonate containing 20 mc of activity, 15 g of crude DDT (42% yield based on EtOH) was obtained. Two crystallizations from ethyl alcohol yielded 6.11 g of *p,p'* DDT (17% yield) having a melting point of 107–107.5° C. The specific activity of the product was approximately ½ mc/g.

The residue is currently being treated to recover additional amounts of the *p,p'*-isomer as well as the *o,p*-isomer.

It is planned to submit a detailed report of this work elsewhere.

References

1. Fields, M., Leaffer, M. A., and Rohan, J. *Science*, **109**, 35 (1949).
2. Tracerlog No. 31, p. 10 (1950), Tracerlab, Inc.
3. Sakami, W., Evans, W. E., and Gurin, S. *J. Am. Chem. Soc.*, **69**, 1110 (1947).
4. Van Bruggen, J. T., Claycomb, C. K., and Hutchens, T. T. *Nucleonics*, **7**, 45 (1950).
5. Ropp, G. A. *J. Am. Chem. Soc.*, **72**, 2299 (1950).
6. Cox, J. D., and Turner, H. S. *J. Chem. Soc.*, 3176 (1950).
7. Mosher, H. S., *et al. Ind. Eng. Chem.*, **38**, 916 (1946).

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Protamine, Chylomicrons, and Clot Formation[1]

W. D. Brown

Department of Physiological Chemistry, University of Lund, Lund, Sweden

The main intestinal lymph channels of 14 rats fed 1 ml of corn oil were cannulated by the technique of Bollman *et al.* (*1*). Addition of 0.2 mg of protamine (clupein, Vitrum, Stockholm) to 1 ml of chyle caused immediate flocculation of the chylomicrons. The floccules rose to the surface during the following 30 min leaving a clear subnatant fluid. Five samples of chyle were adjusted to pH 7.4 with *N* HCl and 0.1 ml aliquot parts from each sample were mixed with quantities of protamine ranging in weight from 2.5 to 20 μg in multiples of 2.5 μg. The minimum quantity of protamine causing flocculation varied from 0.05 to 0.20 mg per ml of chyle. The pH of aliquots of normal chyle (7 samples) and chyle containing flocculated chylomicrons (5 samples) were gradually changed from 7.4 to 2 or 12, and the isoelectric point of normal chylomicrons in intestinal lymph was determined by the technique of Ludlum *et al.* (*2*). This was found to lie between pH 4.6 and 4.9. Lymph chylomicrons in the human subject are apparently stabilized with albumin (*3*) (isoelectric point pH 4.7), and it is clear that the same is true of the rat. The protamine-flocculated chylomicrons dispersed to form a stable emulsion over the pH range less than 4.7 and flocculated again if the pH was readjusted to a value greater than 4.7. Evidently protamine is adsorbed to the interface of lymph chylomicrons in the interisoelectric region of albumin and protamine (pH 4.7–12) causing loss of surface potential followed by flocculation. The reaction appears to be similar to that discussed by Elkes *et al.* (*4*) in the course of examination of effects of proteins on detergent-stabilized emulsions.

Protamine was added to 7 chyle samples (1 mg/ml) and allowed to stand for 30 min. The samples were then centrifuged at 3000 rpm for 2 min when a crystal-clear subnatant fluid was obtained. It is possible that lymph clarified in this manner contains all the non-chylomicron lipid and that the procedure can be used to facilitate analysis of the composition of lymph chylomicrons, or the fluid in which they are suspended. The mean total fatty acid content determined by a modified Schmidt-Nielsen technique (*5, 6*) of the whole chyle samples and clear subnatants was, respectively, 3000 (range 5000–1500) mg%, 34 (60–12) mg%. These observations suggest that the fat in intestinal lymph is almost entirely in chylomicron form during fat absorption, but it remains to be shown that only the chylomicrons are separated from lymph by this treatment. However, no differences in the distribution of proteins in thrombin-treated chyle before and after clarification by protamine were detected (*7*) by the Tiselius electrophoretic technique.

The samples of normal chyle which were collected during the present investigation usually slowly clotted on standing. The clots did not retract and they bound large quantities of lymph which were difficult to expel by compaction. The chylomicrons remained suspended in the lymph fluid recovered by compaction and imparted to it the characteristic milkiness of freshly drawn chyle. In several of the chyle samples treated with protamine, formation of a light clot and flocculation of the chylomicrons occurred within several seconds of treatment. The clot bound chylomicrons so that when it was lifted out of the lymph, the chylomicrons were lifted out with it leaving partially or completely clarified lymph behind. It did not bind lymph fluid and, in this respect, on removal from the lymph it resembled a compacted clot from normal lymph. The reaction was evidently associated with surface changes on the chylomicrons, and it was not a clotting reaction in the usual sense.

Blood was drawn 3 hr after feeding 8 rats 4 ml of olive oil/kg body wt. The effect of protamine on the serum chylomicrons visible in the darkfield microscope (1200 ×) was ascertained. In all 8 samples the chylomicrons were flocculated into immobile clumps by 2 to 3 mg of protamine/ml of serum; 1 mg/ml had little or no visible effect. Thus the minimum dose of protamine causing flocculation of chylomicrons in serum is considerably higher than that required to flocculate chylomicrons in intestinal lymph. Addition of 3.3 ml of a protamine sample/ml of serum induced changes in the electrophoretic pattern of serum owing to association of albumin with protamine (*8*), and it may well be that the larger dose required to flocculate the serum chylomicrons is due to competition between

[1] Many samples of chyle used in this investigation were supplied by B. Borgström and R. Blomstrand.

the stabilizing protein film about the serum chylomicrons and albumin in the disperse phase, for the protamine.

References

1. Bollman, J. L., Cain, J. C., and Grindlay, J. H. *J. Lab. Clin. Med.*, **33**, 1349 (1948).
2. Ludlum, S. DeW., Taft, A. E., and Nugent, R. L. *Colloid Symposium Monograph*, **8**, 277 (1930).
3. Frazer, A. C. *Discussions Faraday Soc.*, **6**, 81 (1949).
4. Elkes, J. J., Frazer, A. C., Schulman, J. H., and Stewart, H. C. *Proc. Roy. Soc.* (*London*), **A184**, 102 (1945).
5. Schmidt-Nielsen, K. *Compt. rend. trav. lab. Carlsberg. Sér. chim.*, **24**, 233 (1942).
6. Brown, W. D., Frazer, A. C., Power, W. F., and Sammons, H. G. Unpublished data.
7. Borgström, B., and Laurell, C. B. *Acta Physiol. Scand.*, in press.
8. Hoch, H., and Chanutin, A. *J. Biol. Chem.*, **197**, 503 (1952).

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A Syringe Carrier and Egg Clamp for Intravenous Inoculation of Chick Embryo[1]

Robert Goldwasser and M. C. Shelesnyak

Israeli Institute for Biological Research, Ness Ziona, Israel, and Weizmann Institute of Science, Rehovoth, Israel

The great range of potentialities of the chick embryo for the study and utilization of the relationships between viruses and susceptible cells has been exploited, in part, by various methods of inoculation: allantoic, amniotic, chorio-allantoic, intracerebral, intravenous, and yolk-sac. Inoculation by the intravenous route was first used by Polk, Buddingh, and Goodpasture in 1938 (*1*), and the current improved technic was described by Eichhorn in 1940 (*2*). It has been stated, however, that widespread application for the intravenous method has not been found (*3, 4*).

A study, undertaken by one of us (R.G.), required a collection of serial blood samples taken at 1–2-hr intervals, from the same, 10–16-day-old chick embryo. To overcome the prohibitively high casualty rate resulting from "free-hand" injection and bleedings, an apparatus was designed and built which consists of a rigid movable syringe carrier and an adjustable egg-clamp (Fig. 1).

The syringe carrier consists of two rigid rods. One, 30 cm × 2.5 cm and one 40 cm × 2.5 cm; the larger, a vertical one (1) fixed to the work table, and the smaller, a horizontal one (2) attached to the upright rod with a bar-clamp (3) allowing for coarse vertical and horizontal movement. Attached to one end of the vertical rod is a revolving stage (4 and 5) consisting of 2 circular plates (10 cm diam.), a fixed one (4) carrying a movable disc (5), actuated by a small spur gear (6) meshed into the geared edge of the moving plate. The center of the stage revolves about the long axis of the horizontal rod. A machine slide with bedded strip (7) is fixed to the revolving stage along the diameter. At 90° to the slide, which is fixed to the revolving stage, and bisecting it, is a second machine slide (8) and bedded strip. This slide and bedded strip is actuated up and down along the first slide and bedded strip by a worm-drive screw (9). The second (the outer machine slide), also actuated by a worm-drive screw (10) has a carriage (11), for holding various sizes of hypodermic syringes.

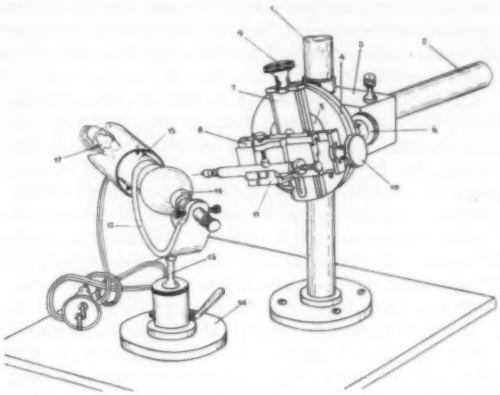

Fig. 1.

The carrier thus allows for the forward and backward motion of the entire syringe, by actuating the outer slide (10); the raising and lowering of the syringe by moving the inner slide (9); and adjustment of the angle of attack of the needle attached to the syringe by rotation (6) of the circular stage. Fine movement along the cylindrical axis of (2) can be achieved by incorporation of a rack and pinion in clamp (3).

The device permits the accurate and precise placement of the hypodermic needle at the proper angle, and entry into, and removal from the blood vessel, without erratic motion.

The other unit, the egg-clamp, consists of a U-shaped cradle, (12), mounted from below to a ball-and-joint swivel, (13), attached to a heavy but movable base (14). The egg is held at the air chamber and opposite ends. The air-chamber end fits into a fixed tube (2.0 cm diam.) (15), while the opposite holding point is an adjustable, spring-loaded rod with a small (0.75 cm diam.) soft rubber cup (16). The air-sac-holding tube extends beyond the U-cradle and contains a 25-w lamp for transillumination (17) of the embryo.

Selected eggs are transilluminated, the position of one of the large fixed veins lying in the chorio-allantoic membrane is marked on the shell, and the direction of the blood flow (which is toward the point where the fixed veins join the free allantoic vein) is indicated. A triangular segment of eggshell over the selected vein, of about 1–1.5 cm on each side, is re-

[1] Aided by a grant to the Department of Experimental Biology of the Weizmann Institute of Science from the Damon Runyon Memorial Fund for Cancer Research, Inc.

moved in the usual manner using a dental engine with a drill or an abrasive disc. Care is taken to avoid damaging the eggshell membrane. A drop of sterile liquid paraffin placed on the exposed area makes the membrane transparent. The egg is placed in the holder with the air-sac toward the light source (15) and with the selected vein on top. The long axis of the blood vessel is set approximately parallel to the work-table and in line with the syringe. The syringe-carrier is adjusted so that the needle forms an angle with the blood vessel of about 15°, and rests on the surface of the eggshell membrane over the blood vessel. The needle is then driven forward, and into the vein, by manipulating the screw (10).

Injection is always made in the direction of the blood flow, and withdrawal of samples preferably in the opposite direction. The needle is withdrawn slowly; but in cases following injection, only after a pause of several seconds. In our experience bleeding after removal of the needle, even from 10–12-day-old chicks rarely occurred. It was not necessary to reseal the egg in the course of these studies even though incubation was carried forward for several days after veno puncture.

In our experiments on 10- to 14-day-old chick embryos, we have injected over 2500 eggs, using the apparatus described, with a casualty rate of less than 3%, and more than 250 eggs have had blood withdrawn from 2–4 times, with less than 10% loss. Routine bleedings of 0.1–0.2 ml of blood at 1–2-hr intervals can be carried out with ease for 4–6 bleedings (up to 7 or 8 with increasing difficulty). In one series, 15 chick embryos were bled every 2 hr for 8 hr, withdrawing 0.2 ml of blood each time without any casualty.

References

1. Polk, A., Buddingh, G. J., and Goodpasture, E. W. *Am. J. Pathol.*, **14**, 71 (1938).
2. Eichhorn, E. A. *Science*, **92**, 245 (1940).
3. Beveridge, W. I. B., and Burnet, F. M. The Cultivation of Viruses and Rickettsiai in the Chick Embryo. Med. Res. Counc. Spec. Rep. Ser. No. 256. London.
4. Goodpasture, E. W., and Buddingh, G. J. In T. M. Rivers, ed., *Chick-Embryo Technics*. Philadelphia : Lippincott, Chap. IV (1948).

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A Mechanical Fly-Tagging Device

John W. Klock, David Pimentel, and Robert L. Stenburg

Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia

A mechanical device has been developed for tagging flies that are to be used as experimental free-flying insects. The tagging consists of gluing 1-in. lengths of brightly colored nylon thread to the thoraces of flies anesthetized with carbon dioxide. This procedure permits suitable test insects to be more readily located, recovered, and identified, and is particularly useful for aircraft-disinsectization studies. The bright colors are used to aid in locating the flies and to distinguish between different series of releases made in the same enclosure. The 1-in. length of thread extending directly back from the thorax of each tagged fly is readily grasped with forceps without agitating the fly into flight. The captured insects are then transferred to holding cages. When properly attached, the threads do not interfere with the normal activities of the flies.

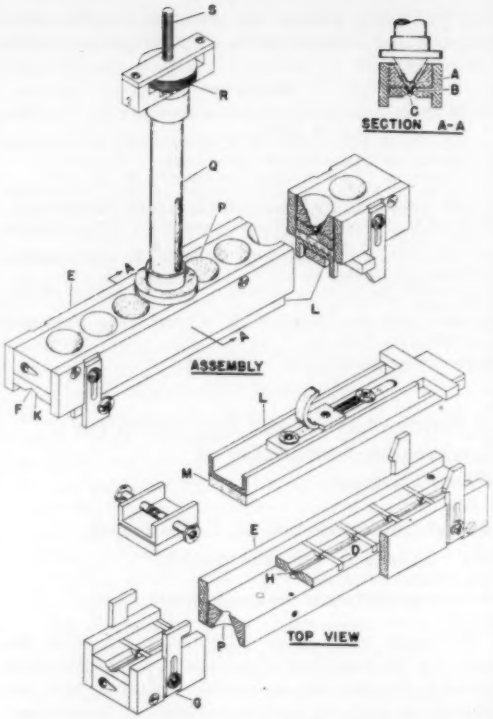

FIG. 1. Drawing of a fly-tagging device.

Originally a manual method was used to attach threads to flies' thoraces, using high-melting-temperature paraffin. A small amount of the paraffin was put on the end of a piece of thread and this in turn was placed on the dorsum of the thorax. A warm metal rod was used to keep the paraffin melted and to hold the thread in contact with the anesthetized fly until the paraffin hardened. In about an hour the flies became accustomed to the attached threads and resumed normal activity. No fly injury has been observed, but proper precautions must be taken to prevent inactivation of the wings. Using this method, a highly skilled worker has sexed and attached threads to as many as 300 female flies an hour for short periods. The procedure is quite tiresome when large numbers of flies are to be tagged, and relatively unskilled workers have been able to produce only about 800 tagged flies per day. With the mechanical device, workers

with comparable skill can tag from 1200 to 1500 flies per day without undue fatigue.

The mechanical unit consists of a fly-holding frame and glue dispenser, both made of aluminum, and an ordinary ¼-cc hypodermic syringe. The holding frame shown in Fig. 1 (top view) is a troughed bar divided into 25 compartments by means of notched ribs (D), and a foam-rubber-padded cover (L). A nylon thread (C in section A-A) is held in the bottom of the groove (F) by being stretched between jam cleats at both ends of the frame. Anesthetized flies are placed upside down in the trough (K) with their heads toward the holes (H) centered about 3/16 in. from the ribs. The frame is tilted slightly upward from the right end and tapped lightly causing the flies to slide down until their heads rest against the ribs. They are now in such a position that a conical hole (P and H), extending from the under side of the frame, is centered under the thorax of each fly. The cover (L) padded with sponge rubber (M) is snapped into place to hold the flies securely and the whole unit is inverted to expose the thoraces of the flies through the conical holes.

Glue is dispensed with a ¼-cc syringe held in the dispenser (Q). A micrometer screw (S), attached to the end of the dispenser barrel, moves the syringe plunger forward. The nose of the dispenser is placed in each hole and the knurled wheel (R) turned 1 notch clockwise. This procedure placed 1/1600 ml of Duco cement, thinned with 50% acetone, on each fly at the point where the thorax touches the nylon thread. The holding frame is now turned right side up, the cover removed, and the chain of 25 flies is taken out. The string is cut in front of the head of each fly and the separated flies are then placed in holding cages for later release tests.

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A Quantitative Analysis of the Factors Involved in the Variations in Virulence of Rickettsiae[1]

Winston H. Price[2]

Departments of Biochemistry and Epidemiology, Johns Hopkins University, School of Hygiene and Public Health, Baltimore, Maryland

Previous investigators have observed that strains of *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever, recovered from ticks in nature differed widely in their apparent pathogenicity for guinea pigs (*1*). Furthermore, Spencer and Parker (*2*) found that, if *Dermacentor andersoni* ticks infected with virulent spotted fever were left in the icebox for several months, a ground suspension of these ticks injected into guinea pigs produced fewer, if any, spotted fever symptoms, yet immunized the animal against subsequent infection by the virulent agent. If such ticks were given a blood meal and then injected into guinea pigs, these animals came down with virulent spotted fever. This was termed a reactivation phenomenon. Unfortunately, the above observations are open to some criticism since little attention was paid to the quantitative relationships. However, this system suggested an intensive study of the factors involved in the variation in virulence of an intracellular microparasite.

The series of experiments here reported was undertaken to establish more precisely by quantitative methods the differences in virulence of the representative strains of *R. rickettsii*, the possibility of modifying strain virulence by animal passage and by tick passage, the nature of the reactivation phenomenon, and the identity of the enzyme systems principally involved in these changes of virulence.

Characterization of Strain Variation in Virulence.[3] The first series of experiments was planned to establish by quantitative methods the range in virulence of four representative strains of *R. rickettsii*. The following procedures were adopted. The strains were isolated from yolk sacs by a procedure similar to that of Wisseman *et al.* (*3*). The number of rickettsiae in the suspension was determined by the electron scope method described in Table 1. Each strain was titered in guinea pigs and chick embryos as described in Table 1. This experiment was repeated three times with similar findings. The more virulent organisms grow better in the guinea pig than the less virulent strains, the major differences being particularly noticeable in the heart, brain, and blood. Thus strain R reaches a maximum concentration of 300 and 100 LD_{50} in the brain and heart, respectively, and of 300 LD_{50} in the blood. Strains S and T show a maximum of only 1 to 3 LD_{50} in the brain and heart, and only about 10 LD_{50} in the blood.

Guinea pigs injected with 10,000 LD_{50} of one strain are immune to the three other strains. Furthermore, strains T and U will completely protect guinea pigs from strain R when given in 100 times the concentration (10^6 LD_{50} of T or U and 10^4 LD_{50} of R) with both weakly virulent and virulent strains injected intraperitoneally simultaneously.

All strains shown in Table 1 possess a toxin[4] similar

[1] This work was supported by a grant from the National Institutes of Health, United States Public Health Service.

[2] I wish to express my sincere appreciation to Carl L. Larson, Director of the Rocky Mountain Laboratory, National Microbiological Institute, National Institutes of Health, Hamilton, Mont., for placing the facilities of the laboratory at my disposal. A few of the experiments reported in this paper were carried out at that laboratory. I wish also to thank David Lackman for carrying out many of the complement fixation determinations. Acknowledgment is also due to H. Sargent, L. Hughes, Mrs. M. Smith, Miss H. Emerson, C. H. Sawyer, and E. G. Pickens for valuable technical assistance in various phases of this work.

[3] All LD_{50} determinations refer to egg titrations. Using the R strain, 1 LD_{50} is equivalent to minimal infectious dose (ID_{50}) for guinea pigs. In all instances where eggs and tissues are titrated, the LD_{50} refers to the number of LD_{50} in 0.5 ml of a 10% suspension.

[4] E. J. Bell and E. G. Pickens of the Rocky Mountain Laboratory, in an independent series of investigations, have found that *R. rickettsii* produce a toxin.

TABLE 1*

A COMPARISON OF VARIOUS STRAINS OF SPOTTED FEVER†

Strain	Scrotal reaction	Days of fever	Av height of fever	Fatality	Minimum number of ricksettsiae		
					To infect		For 1 LD_{50} for eggs
					Eggs	Pigs (ID_{50})	
R	++++	8.1 ± 1.2	40.6 ± 0.16	12/20‡	1–10	50–200	50–200
S	++	4.1 ± 0.52	40.4 ± 0.12	0/20	1–10	50–200	50–200
T	—	4.3 ± 0.82	40.4 ± 0.14	0/20	1–10	50–200	50–200
U	—	0	—	0/20	1–10	—	50–200

* Twenty male guinea pigs weighing about 400 g were used for each strain. Each pig was injected intraperitoneally with 1000 ID_{50}'s of the appropriate strain. All strains before injection were isolated according to a procedure similar to that of Wisseman *et al.* (*3*). All parts of the experiment were carried out at the same time, and the same suspension was used for the guinea pig and egg titration of each strain. The number of organisms in a suspension was determined by electron microscopic count. A positive complement fixation reaction was used to determine the number of organisms infective for guinea pigs. In determining the number of rickettsiae necessary to infect eggs, the lowest number of organisms was selected that when injected into chick embryos gave positive microscopic rickettsial smears after two blind passages in chick embryos. Five-day-old chick embryos were used and inoculated into the yolk sac. ++++ indicates scrotal hemorrhage, necrosis, and sloughing off, and ++ indicates scrotal redness and swelling. Fever was taken as any temperature of 39.8° C or over.

† The rickettsiae in the suspensions have been counted under the electron microscope; a standardized suspension of latex particles was used. The absolute error of this counting method is 6% (*4*).

‡ Numerator indicates number of animals dying from spotted fever.

to that reported for *R. prowazeki*. Mice injected intravenously with the various strains begin to die in a few hours. The toxic effect is neutralized by specific immune serum. Purification experiments indicate that the toxin is associated with the viable rickettsiae. Mice titrations carried out with rickettsial suspensions prepared from yolk sacs, the number of organisms in the suspensions being determined by the electron microscope as described in Table 1, indicate that all strains have approximately the same amount of toxin. It is still possible, however, that in guinea pigs the virulent organisms have more toxin. Technical difficulties make the latter determination impossible.

All strains shown in Table 1, when grown in yolk sacs, have about the same amount of hemolytic factor, which is similar to that reported for epidemic and endemic typhus. The hemolytic factor can be neutralized by specific immune serum. As with the toxic factor, it is possible that the more virulent strains have more of the hemolytic factor when they multiply in the guinea pig than do the less virulent strains.

Within the experimental error of about 50 per cent, the minimum number of rickettsiae necessary to infect and kill chick embryos is the same irrespective of the virulence of the strain for the guinea pig (cf. Table 1). Therefore, within the error of the method, animals injected with the same LD_{50} dose of strains of varying virulence receive the same number of organisms.

Under the conditions shown in Table 1, 3.0 mg of cortisone injected subcutaneously daily for 96 hr before infection and daily for 72 hr after infection had no detectable effect on the virulence of strains R, S, T, and U. However, larger amounts of cortisone have a protective effect against *R. rickettsii*.

All strains, R, S, T, and U, grow to the same extent in chick embryo yolk sacs, which contain between 10^6 to 10^7 LD_{50}'s. It is of interest in this connection that in chick embryos *R. rickettsii* exhibit a multiplication pattern that is different from that of such other intracellular parasites as animal viruses. This statement is supported by the observation that *R. rickettsii* does not lose its infectious property before beginning to multiply, as do other intracellular parasites such as some animal viruses like influenza (*5*).

Animal and Tick Passage of R. rickettsii. Spotted fever strains isolated west of the Mississippi River from the rabbit tick, *Haemaphysalis leporis-palustris*, have given only very mild symptoms resulting in 2 to 3 days of fever (39.8–40.1° C) when injected into male guinea pigs (*1*). Our experiments so far have confirmed these results. Furthermore, egg titrations show that this very low virulence is not due to a low concentration of rickettsiae. These rickettsiae multiply very poorly in the guinea pig (1 LD_{50} or less in the spleen).[5]

Experiments were conducted to ascertain the effect of passage of strains through two different species of ticks, *Dermacentor andersoni* and *Haemaphysalis leporis-palustris*.

Passage of these weakly virulent strains through one complete life cycle in *D. andersoni*, from which species of tick many virulent strains have been isolated (*1*), does not increase their virulence for the guinea pig. Passage of virulent strains (similar to strain R in Table 1) through one complete life cycle in the rabbit tick does not decrease their virulence for the guinea pig. Three hundred and four *D. andersoni* and 295 rabbit ticks have been tested so far in these experiments. In all these studies the larvae were infected with the appropriate strains by feeding on infected guinea pigs or rabbits. The larvae were then fed on normal animals in the nymphal, adult, and next larval stage and tested at this stage. Careful attention was paid to the number of organisms injected in all experiments. Attempts to modify the strain virulence of *R. rickettsii* by passage in *D. vari-*

[5] After one egg passage the virulence of these strains is increased to that shown for strain S in Table 1.

abilis, *A. maculatum*, and *R. sanguineus* have been completely negative.

On the other hand, by continued spleen passage in cottontail rabbits, the virulence for the guinea pig of the virulent strain referred to above was decreased. By starting out with a strain similar to the R type, a strain similar to the S type was obtained after 8 to 13 spleen passages. This strain still caused the same fairly mild spotted fever symptoms in the cottontail rabbit as the original rickettsial suspensions before passage. If this weakly virulent strain was transferred back several times in guinea pigs by spleen passage, the original virulent strain was obtained. These experiments were repeated with two virulent strains. With another virulent strain, a strain similar to T was obtained. Careful attention was paid to quantitative relationships in all these experiments, i.e., the concentration of rickettsiae injected after the rabbit passages was compared to comparable concentrations of the rickettsial strain before passage. Other experiments indicate that the virulence of some strains of *R. rickettsii* can be increased by one passage in man. Our data would therefore indicate that the virulence of *R. rickettsii* for the guinea pig can be modified by animal passage but not by multiplication in their arthropod hosts.

The Reactivation Phenomenon. It has been thought that the reactivation phenomenon occurred because there were enough rickettsiae to immunize but not enough to infect. Our analysis of this phenomenon has shown that this is not true. Female *D. andersoni* were fed on guinea pigs infected with 1000 LD_{50}'s of the virulent R strain. After the eggs were laid, the resulting larvae and nymphs were also fed on infected guinea pigs. The adults were left 1 month at room temperature and were then stored at 6° C for 5 months.[6] Lots of ticks were removed at this time and ground into tick suspensions and titered in eggs. Such suspensions were found to contain 1000 LD_{50}'s per 0.5 ml. This is 1000 times the number of spotted fever organisms necessary for guinea pigs to come down with virulent spotted fever. Yet, when 20 guinea pigs were infected with the suspension containing the 1000 LD_{50}, 4 showed slight fever for 2 days (39.8°–40.0° C) and the other 16 remained normal (38.6°–39.6° C). All guinea pigs proved to be immune to 100 LD_{50} challenge doses of the virulent spotted fever. The rickettsiae could be reactivated, or made virulent by leaving the ticks at 37° C for 48 hr (*2*) or by passing them once through chick embryos. After reactivation, as little as 1 to 10 LD_{50} would cause typical virulent spotted fever, with the animals showing the typical symptoms and immune responses shown in Table 2. So far fifteen different experiments, involving 505 guinea pigs and over 5000 ticks, have been carried out. All data from these experiments are consistent with the above results. The avirulent phase was also found in eggs, larvae, and nymphs of ticks previously infected in the laboratory. Spotted fever rickettsiae in the avirulent phase can be isolated in nature from adult *D. andersoni* which have not fed.

TABLE 2

A COMPARISON OF THE VIRULENT AND AVIRULENT PHASES OF *R. rickettsii* FOR THE GUINEA PIG*

Avirulent phase	Virulent phase
Grows poorly (0 LD_{50} in spleen)	Grows well (300 LD_{50} in spleen)
Produces low, if any complement fixation titer (0–1: 20)	Produces high complement fixation titer (1: 254–1: 1024)
Produces toxin neutralizing antibody	Produces toxin neutralizing antibody
Cannot be passed serially from pig to pig	Can be passed from pig to pig
Produces immunity to virulent spotted fever	Produces immunity to virulent spotted fever
Produces no immunity to boutonneuse fever	Produces immunity to boutonneuse fever
Changed to highly virulent form by 1 egg passage	Virulence not changed on 1 egg passage
Changed to highly virulent state by keeping infected ticks at 37° C for 72 hr	Virulence not changed by keeping ticks infected with virulent form at 37° C for 72 hr
Produces little, if any, fever	Produces about 8 days of fever
Produces no scrotal reaction	Produces severe scrotal reaction
No fatality of guinea pigs	25–50% fatality

* Table based on 100 guinea pigs injected with 100 LD_{50} of avirulent phase and 100 guinea pigs injected with 100 LD_{50} of virulent phase.

All attempts to demonstrate multiplication of this avirulent phase of *R. rickettsii* in the guinea pigs have failed. It should be noted that the avirulent phase of *R. rickettsii* is different from the weakly virulent strains S, T, and U, since these strains cannot be activated by one egg passage or by a blood meal in ticks.

Table 2 gives a summary of the properties of the virulent and avirulent phases of *R. rickettsii* in the guinea pig. Other experiments have indicated that the reactivation phenomenon is not due to selection, spontaneous mutation, or to an inhibitor in the avirulent tick suspensions which prevent the guinea pigs from coming down with spotted fever.[7] Once reactivation occurs, the rickettsiae can be transferred by spleen passage from guinea pig to guinea pig for at least 16 transfers. The change from the avirulent to the virulent state thus appears to be hereditary. It is of interest that Q fever rickettsiae in adult *D. andersoni* have not been found to show the reactivation phenomenon (*6*, *7*). It is clear that an understanding of this reactivation phenomenon in *R. rickettsii* will give us a much better understanding of the factors that are

[6] Some lots of infected ticks must be left as long as 12 months at 6° C. In carrying out the actual experiments, 10 to 30 ticks were ground and made up to 15.0 ml in a solution containing 0.22 *M* sucrose and 0.04 *M* potassium phosphate, pH 7.4; 0.5 ml of this suspension was then titered in eggs. Each egg also received 750 units of penicillin and 400 units of streptomycin.

[7] Recent experiments indicate that the avirulent phase is not due to the fact that the tick suspensions contain dead rickettsiae which interfere with the multiplication of living virulent rickettsiae. All evidence indicates that there is a change in the virulent organism which makes it avirulent.

concerned with the virulence of rickettsiae, and perhaps of other infectious agents, and may also give valuable clues as to how infectious agents persist in nature. It might be mentioned that the avirulent phase of *R. rickettsii* has properties similar to those of masked viruses (*8*), in that a non-infective state exists although the parasites can be made infective by the appropriate procedures. If this phenomenon turns out to be more common than is now thought, it must be taken into account in any study of the natural history of an infectious agent. In such studies the presence or absence of the agent is usually determined by infectivity measurements. However, in view of the above results the failure to find an infective agent by infectivity determinations would not necessarily mean that the agent is not present.

Enzyme Studies. In the final analysis, the difference in the virulence of various strains is probably due to a difference in their enzyme systems. Experiments were therefore carried out on strains R, S, T, and U described in Table 1, to see if any enzyme difference could be found. Because Bovarnick and Miller (*9*) and Wisseman *et al.* (*10*) have found part of the Krebs cycle to be functioning in *R. mooseri*, this system was studied first.

No differences have been found so far in any of the enzyme systems of the various strains. All strains of purified rickettsiae (*cf.* Table 1 for procedure) oxidize glutamate, pyruvate, α-ketoglutarate, succinate, fumarate, malate, and oxalacetate. The oxidation of pyruvate and glutamate is greatly stimulated by the addition of inorganic phosphate. In three experiments of seven using carefully washed rickettsiae, a definite phosphorus uptake was observed when glutamate was oxidized. No phosphorus was taken up anaerobically. It would seem that in *R. rickettsii* the oxidation of substrates is coupled to phosphorylation, as it is in other types of cells. When glutamate is oxidized, succinate accumulates in the presence of malonate. Although no oxidation occurred with added citrate, isocitrate, or *cis*-aconitate, preliminary evidence indicates that the addition of pyruvate and oxalacetate leads to the accumulation of citrate in the presence of fluoroacetate, coenzyme A, adenosine triphosphate coenzyme 1, α-lipoic acid, and glutathione. If this result is substantiated by future experiments, the indication is that a tricarboxylic acid is concerned in rickettsial metabolism. None of the reactions listed above was found in normal yolk sacs treated by the procedure used to isolate the rickettsial preparations.

Although rickettsial preparations purified by the celite and albumin procedure have been found to contain phosphatase and other enzymatic activities, treatment of such preparations with antisera prepared to normal yolk sac material gets rid of these enzymes activities, leaving only the Krebs cycle reactions mentioned above. Rickettsial preparations purified to such a degree that no host material can be detected serologically contain both pentosenucleic acid and deoxyribonucleic acid.

Details of all this work will be published in future papers.

References

1. Parker, R. R. *Bull. Montana State Board of Health, No. 26*, 33 (1923); Parker, R. R. Unpublished.
2. Spencer, R. R., and Parker, R. R. *U. S. Public Health Repts.*, **39**, 3027 (1924).
3. Wisseman, C. L., Jackson, E. B., Hahn, F. E., Ley, A. C., and Smadel, J. E. *J. Immunol.*, **67**, 123 (1951).
4. Backus, K. C., and Williams, R. C. *J. Applied Phys.*, **21**, 11 (1950).
5. Henle, W. *J. Exptl. Med.*, **90**, 1 (1949).
6. Philip, C. B. Personal communication.
7. Price, W. H. Unpublished.
8. Shope, R. E. *J. Exptl. Med.*, **77**, 127 (1943).
9. Bovarnick, M. R., and Miller, J. C. *J. Biol. Chem.*, **184**, 661 (1950).
10. Wisseman, C. L., Hahn, F. E., Jackson, E. B., and Smadel, J. E. *Federation Proc.*, **10**, 424 (1951).

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Inductive Epithelio-mesenchymal Interaction in Cultured Organ Rudiments of the Mouse

Clifford Grobstein[1]

National Cancer Institute,
National Institutes of Health, Bethesda, Maryland

The importance of inductive interaction between tissues of the developing embryo has been amply demonstrated but the mechanisms remain obscure (*1*). Studies of inductive processes in the mammalian embryo have been extremely limited due to technical difficulties. Recently it has been found that very early rudiments of the mouse submandibular salivary gland (*2*), kidney, and lung (*3*), continue surprisingly normal morphogenesis at the glass-clot interface in Carrel flasks, and that each of these rudiments can be separated into viable epithelial and mesenchymal components by exposure to trypsin—as has been described for chick rudiments by Moscona and Moscona (*4*). These procedures have allowed study of epithelio-mesenchymal interaction by observing the behavior *in vitro* of heterogeneous combinations, e.g., submandibular epithelium and kidney mesenchyme (nephrogenic cord), or kidney epithelium (ureteric bud) and submandibular capsular mesenchyme. The results of one such experiment are reported here to indicate that: (1) the method affords approaches to problems of inductive interaction of embryonic tissues; (2) as has been inferred on indirect evidence (*5*), inductive processes similar to those described in lower vertebrates also occur in mammals; (3) even in the relatively simple epithelio-mesenchymal systems considered here, at least two types of inductive processes appear to be operating.

All embryos were BALB/C × C3H F_1 hybrids. Under a dissecting microscope, the submandibular rudiments were isolated on the 13th day of pregnancy (observation of a vaginal plug = 0 day), kidney rudi-

[1] With the technical assistance of Derrell Freese, George Parker and Edward J. Soban.

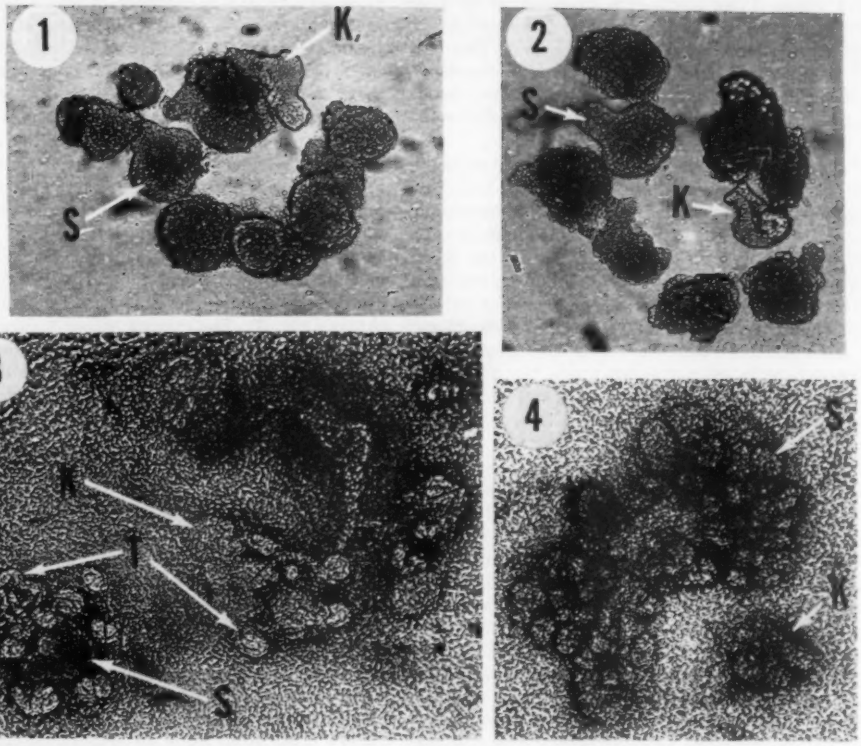

FIG. 1. One kidney (K) and one submandibular (S) epithelial rudiment combined with a number of kidney mesenchyme fragments. Just after explanation. (×50.)

FIG. 2. As Fig. 1, except mesenchyme is from submandibular capsule. (×50.)

FIG. 3. Culture in Fig. 1 after 3 days. Note the branching kidney epithelium, with associated early coiled tubules (T) derived from the rudiment on the right in Fig. 1; and the nondeveloping submandibular epithelium, with closely associated coiled tubules, derived from the rudiment on the left in Fig. 1. (×50.)

FIG. 4. Culture in Fig. 2 after 4 days. (×50.)

ments on the 11th day. At these stages both rudiments consist of a simple epithelial component expanded distally preparatory to branching, and a surrounding mesenchymal component distinguishable from the generalized loose mesenchyme. In the case of the kidney, the "mesenchymal" component is the posterior end of the nephrogenic cord; in the case of the submandibular gland, it appears to be a condensation of the ordinary loose mesenchyme.

The isolated rudiments were placed in covered tissue dishes in a 1:1 mixture of horse serum and Tyrode's solution, in an atmosphere containing 5% CO_2. The latter precaution prevents rise of pH in the fluid with resulting stickiness of the mesenchyme. Pairs of rudiments were transferred to 3% trypsin (Difco 1:250) in Tyrode's solution minus calcium and magnesium salts as recommended by Moscona (*4*). Neither preliminary exposure to Ca-Mg-free Tyrode's, nor incubation during exposure were found necessary for present purposes. After 5–10 min the rudiments were flushed in and out of an orally controlled pipet of diameter slightly less than that of the rudiment. Adhering loose mesenchyme dissociated readily and was sheared off of the rudiment as individual cells or small clusters. With continued flushing and gentle manipulation with a cataract knife, the epithelium and condensed mesenchyme separated—the former intact, the latter either intact, or in several large fragments. These components, when transferred to the horse-serum-Tyrode's mixture, showed little tendency to dissociate further and could be put in culture in small clusters in any combination desired. The condensed mesenchyme from each rudiment was separated before culture into 4 fragments for greater convenience in arranging clusters around the epithelium.

Culture was in Carrel D-3.5 flasks at the glass-clot interface. The tissue fragments were quickly oriented in a clotting mixture of rooster plasma (0.6 cc) and nutrient medium (0.8 cc) consisting of horse serum, Tyrode's solution and chick-embryo juice (9 day) in

2:2:1 ratio. After clotting, a supernatant of 1 cc of the nutrient medium was added and changed daily. Aseptic procedures were used throughout. The cultures were incubated at 37–38° C. Daily observations and frequent photographic records enabled the developmental behavior of each individual epithelial rudiment to be followed.

In the experiment under consideration 5 pairs of cultures were prepared. In one flask of each pair, one submandibular and one kidney epithelial component were placed in a close cluster of submandibular capsular mesenchyme fragments (Fig. 2). In the other flask, similar epithelial components from the opposite sides of the same embryos were combined with kidney mesenchyme fragments (Fig. 1). In each flask, therefore, one epithelial rudiment was in homogeneous recombination with its own mesenchyme, the other was in heterogeneous combination. In all cases the mesenchymal fragments rapidly spread and coalesced around both epithelial rudiments.

In all flasks involving submandibular capsular mesenchyme the submandibular epithelium underwent its characteristic morphogenesis as previously noted in cultured intact rudiments (Fig. 4) (*2, 6*). The kidney epithelium, however, rounded up and showed no characteristic kidney morphogenesis. In several cases its general configuration was somewhat suggestive of submandibular epithelium, although there was no formation of adenomeres or other indication of growth and morphogenesis. No significance can be attached to this latter point pending further data. For the moment it can only be said with certainty that kidney epithelium in submandibular capsular mesenchyme fails to show its own characteristic morphogenesis.

On the other hand, this same epithelium in kidney mesenchyme did undergo characteristic morphogenesis. It formed a branching pattern of ducts during the first several days followed, beginning on about the third day, by the appearance of coiled tubules in the kidney mesenchyme at the periphery of, and among, the ducts (Fig. 3). Similar coiled tubules appear in intact 11-day metanephric rudiments cultured under these same conditions (Fig. 5) and appear to represent rudiments of the secretory portion of the uriniferous elements, formed *in vivo* by the nephrogenic cord and secondarily linked to the collecting system arising from the ureteric bud. In the cultures involving kidney mesenchyme, the submandibular epithelial components completely failed to undergo their characteristic morphogenesis, rounding up to form small masses. In close association with these masses, however, coiled tubules developed in the kidney mesenchyme (Fig. 3). The tubules, which tended to develop earlier, and become more prominent around the submandibular rudiment than around the kidney epithelium, were not seen except in close association with one or the other epithelia.

The results in all flasks, although quantitatively variable, were qualitatively the same and were duplicated when the two types of epithelium were tested separately rather than in the same flask. The implication of the results that submandibular and kidney epithelial morphogenesis depends upon specific properties in the associated mesenchyme is supported by other experiments showing that submandibular epithelium fails to undergo morphogenesis when combined with 11-day mandibular arch mesenchyme, 11-day lung mesenchyme, 11-day limb-bud mesenchyme or 8-day somite and lateral plate mesoderm. Similarly, kidney epithelium fails to undergo morphogenesis in 11-day mandibular arch or lung mesenchyme. Moreover, submandibular capsular mesenchyme cultured separately and recombined with submandibular epithelium at each of 3 successive subculture periods of 5–7 days continues to exert a recognizable morphogenic effect, although of declining degree and typicalness.

It would appear, from the reported observations, that tubule formation by nephrogenic cord is less specific in its inductive requirements than morphogenesis of the epithelia tested. Whereas the latter occurs *in vitro* only in the particular mesenchyme normally surrounding the epithelial rudiment in the embryo, the former can be induced by submandibular epithelium *in vitro* and by spinal cord both *in vivo* (*7*) and *in vitro* (*3*). That the effect is not completely nonspecific, however, is suggested by preliminary experiments indicating at least much reduced activity of killed spinal cord and inactivity of 11-day lung, pancreas, and stomach epithelia (*3*).

It is of interest to note that the suggestion of two types of inductive processes seemingly differing in their specificity is reminiscent of data on amphibian primary induction where workers have drawn a distinction between simple nonspecific "evocative" and more complex and more specific "individuation" effects (*8*). Although that situation and the present one are not completely comparable, it is suggestive that primary induction, too, involves an epithelio-mesen-

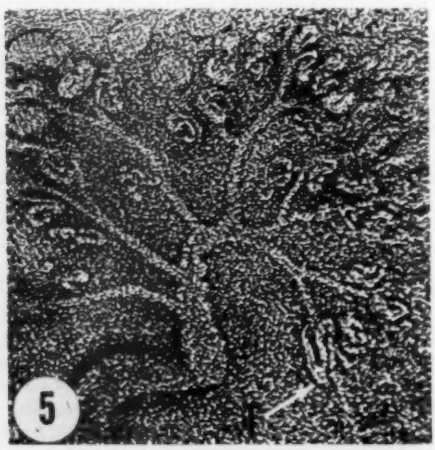

FIG. 5. Metanephric rudiment of 11-day embryo on 8th day in culture. Note branching system of collecting tubules with intercalated coiled tubules. (× 50.)

chymal system. Continued analysis of such systems, isolated and controlled in culture, may reveal fundamental similarities in the patterns of inductive interaction in the whole early embryo and its later subsystems.

References

1. HOLTFRETER, J. *Growth*, Symposium Vol. X, 117 (1951).
2. GROBSTEIN, C. *J. Morphol.*, **93**, (1), (1953).
3. ———. Unpublished data.
4. MOSCONA, A., and MOSCONA, H. *J. Anat.*, **86**, 287 (1952); ———. *Expti. Cell Research*, **3**, 535 (1952).
5. GLUECKSOHN-SCHOENHEIMER, S. *Growth*, Symposium Vol. IX, 163 (1949).
6. BORGHESE, E. *J. Anat.*, **84** 287 (1950).
7. GRUENWALD, P. *Anat. Record*, **86**, 321 (1943).
8. WADDINGTON, C. H. *Organizers and Genes*. Cambridge: Cambridge Univ. Press (1940).

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The Use of Some Synthetic Phosphatides in Antigens for the Serodiagnosis of Syphilis

D. B. Tonks and R. H. Allen

Laboratory of Hygiene, Department of National Health and Welfare, Ottawa, Canada

The cardiolipin antigens used in the serodiagnosis of syphilis contain 3 components: cardiolipin, lecithin, and cholesterol. Cardiolipin is purified from extracts of beef heart and the lecithin may be prepared from beef heart or egg yolk. The substitution of synthetic compounds in place of these naturally occurring components was suggested to us with the synthesis of saturated lecithins by Baer and associates (*1, 2*).

We have obtained samples of various synthetic lecithins from Baer and have tested them as substitutes for beef-heart lecithin in cardiolipin antigens. Other materials synthesized by Baer and his associates have also been investigated as lecithin substitutes. These are L-α-dimyristoyl cephalin, stearoyl glycollecithin, and dipalmitoyl-L-α-glycerophosphoric acid monocholine salt. In addition, tetramyristoyl-bis-(L-α-glyceryl) phosphoric acid (*3*), a material somewhat similar in structure to cardiolipin, has been studied as a cardiolipin substitute. Antigens containing the various synthetic substitutes have been used in the V.D.R.L. microflocculation test and the Kolmer complement fixation test (Table 1).

Three α-lecithins of the L series, namely, distearoyl, dipalmitoyl, and dimyristoyl lecithin were studied. Distearoyl lecithin is sparingly soluble in ethyl alcohol, the basic solvent of cardiolipin antigens. When used in place of beef-heart lecithin in antigen for the V.D.R.L. slide test, the resultant mixture was undersensitive even at the highest possible concentration. Again, in the Kolmer test, only a few antigens could be prepared for trial, but one of these was found to possess a sensitivity quite close to that of Kolmer antigen.

Many mixtures prepared with the more soluble dipalmitoyl and dimyristoyl lecithins were used in the V.D.R.L. microflocculation test, and it was found that the most sensitive antigens had the following composition: cardiolipin, 0.03%; synthetic lecithin, 0.3%; cholesterol, 0.9%. Antigen suspensions prepared from these mixtures were found to increase in sensitivity for the first 4 hr, and then remained constant for 24 hr. If heated for 5 min at 56° C, however, a stable suspension of the same maximum sensitivity was obtained immediately. The most reactive preparations were not quite equal in sensitivity to our V.D.R.L. slide-test antigen. These lecithins were also used in the Kolmer test and levels of sensitivity close to that of Kolmer lipoidal antigen were obtained when mixtures of the following composition were used: cardiolipin, 0.0175%; synthetic lecithin, 0.2%; cholesterol, 0.3%. Others have found synthetic lecithins to be reactive. In a preliminary study, Rosenberg (*4*) noted that antigens (Hinton, Kline, Kolmer, Rein-Bossak, V.D.R.L.) prepared with synthetic dipalmitoyl lecithin reacted antigenically. Kline (*5*) has studied the use of dimyristoyl lecithin as an antigen component with cardiolipin and Faure (*6*) has investigated the substitution of dimyristoyl lecithin for natural leci-

TABLE 1

SUBSTITUTION OF SYNTHETIC PHOSPHATIDES FOR CARDIOLIPIN OR NATURAL LECITHIN IN THE PREPARATION OF ANTIGENS FOR THE SERODIAGNOSIS OF SYPHILIS

Cardiolipin	Lecithin	V.D.R.L. microflocculation test	Kolmer complement fixation test
Tetramyristoyl-bis-(L-α-glyceryl) phosphoric acid		Weakly reactive	Reactive
	L-α-distearoyl lecithin	Weakly reactive	Reactive
	L-α-dipalmitoyl lecithin	Reactive	Reactive
	L-α-dimyristoyl lecithin	Reactive	Reactive
	D-α-dimyristoyl lecithin	Reactive	Reactive
	DL-α-dimyristoyl lecithin	Reactive	Reactive
	Stearoyl glycollecithin	Weakly reactive	Reactive
	L-α-dimyristoyl cephalin		Anticomplementary
	Dipalmitoyl L-α-glycerophosphoric acid monocholine salt	Not reactive	

thin in the Kline test and both the Kolmer and Debains complement fixation tests.

We have also prepared antigens with D-α-dimyristoyl lecithin and DL-α-dimyristoyl lecithin and have used them in the V.D.R.L. slide test in parallel with L-α-dimyristoyl lecithin antigen of the same composition. Very similar results were obtained. There was also good agreement when the 3 lecithins were used in parallel in the Kolmer test.

Stearoyl glycollecithin was used as a substitute for lecithin in a wide range of concentrations in the V.D.R.L. slide test. With syphilitic sera, flocculation occurred but the various antigens were undersensitive compared with V.D.R.L. slide test antigen. Coarse particles, and often small aggregates of particles, were observed with normal sera. In the Kolmer test a level of sensitivity approximately that of Kolmer antigen was obtained with the following antigen mixture: cardiolipin, 0.03%; glycollecithin, 0.075%; cholesterol, 0.3%. No anticomplementary or hemolytic properties were detected.

Difficulty was encountered in the substitution of L-α-dimyristoyl cephalin for beef-heart lecithin due to the limited solubility of the material in absolute ethyl alcohol. Two antigen mixtures were prepared for use in the Kolmer test and they proved to be anticomplementary.

No serological reactivity was observed when dipalmitoyl-L-α-glycerophosphoric acid monocholine salt was used in place of natural lecithin in V.D.R.L. slide test antigen.

The phosphatidic acid, tetramyristoyl-bis-(L-α-glyceryl) phosphoric acid was substituted for cardiolipin in antigen mixtures prepared for the V.D.R.L. test. Flocculation occurred with strongly positive syphilitic sera. When normal sera were examined, the test mixtures were often coarse and difficult to read. In the Kolmer test, certain phosphatidic acid antigen mixtures showed definite reactivity with positive sera, but even the most reactive (phosphatidic acid, 0.08%; lecithin, 0.033%; cholesterol, 0.3%) was less sensitive than Kolmer lipoidal antigen. Possibly other phosphatidic acids may prove to be more satisfactory. Faure (7) has found that unsaturated phosphatidic acids extracted from plants can be substituted for cardiolipin but that the resultant antigen is less reactive.

The use of pure synthetic compounds in the preparation of antigens would offer certain advantages in the standardization of serodiagnostic tests for syphilis. In addition, the investigation holds some promise of revealing the mechanism of reaction and perhaps the molecular groupings which are involved. Further studies are being conducted.

References

1. BAER, E., and KATES, M. *Science*, **109**, 31 (1949); *J. Am. Chem. Soc.*, **72**, 942 (1950).
2. BAER, E., and MAURUKAS, J. *J. Am. Chem. Soc.*, **74**, 158 (1952).
3. BAER, E. *J. Biol. Chem.*, **198**, 853 (1952).
4. ROSENBERG, A. A. *J. Venereal Disease Inform.*, **30**, 194 (1949).
5. KLINE, B. S. *Am. J. Syphilis, Gonorrhea, and Venereal Diseases*, **34**, 460 (1950).
6. FAURE, M. *Ann. Inst. Pasteur*, **82**, 738 (1952).
7. ———. *Bull. soc. chim. biol.*, **31**, 1362 (1949).

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Comments and Communications

Chromatogram Spotting Apparatus[1,2]

THE chromatogram spotting apparatus[3] shown was designed and built in an attempt to standardize the technique of placing liquid material on paper chromatograms in definite amounts. Experience in this laboratory has shown that considerable variability in chromatograms results when several individuals are doing the spotting, as occurs in the case of a paper chromatographic study involving samples of many field replications. This equipment enables the worker to standardize the technique and facilitate ease of operation, thus making it possible for less experienced employees to do uniform, high quality spotting.

The principal error in spotting seems to be due to a failure to place the micropipette at right angles to the paper. This often results in an irregular spot. The parallelogram arm pipette holder eliminates this error. A T-square notched at regular intervals reduces the usual time-consuming process of measuring and marking one-dimensional papers to be spotted. The lighted recess or well in the board directly under the spotting

FIG. 1.

[1] Published with approval of the director, Colorado Agricultural Experiment Station, as G. S. paper No. 525.

[2] This equipment was developed during the course of a biochemical investigation supported in part by the Herman Frasch Foundation.

[3] A complete set of detailed blueprints and photographs may be obtained for $5.00 to cover cost of preparation by writing directly to Clark Livingston, Chemistry Department, Colorado A. & M. College, Fort Collins, Colorado.

area relieves eye strain and provides a warm air space below the paper, thereby increasing the rate at which the spots will dry. A small pull-type drawer serves as a handy storage place for pipettes, etc. The level of the table on which the apparatus is placed is adjusted to bring the level of the pipette to shoulder-height when the operator is in a sitting position.

CLARK H. LIVINGSTON
MERLE G. PAYNE
JESS L. FULTS
ROGER M. BLOUCH
Departments of Chemistry and Botany and Plant Pathology
Colorado Agricultural Experiment Station
Fort Collins, Colorado

Manuscript received December 15, 1952.

Zoological Collecting Expeditions and the Salvage of Animal Bloods for Comparative Serology

ADEQUATE collections of individuals and species of animals are indispensable in the present-day approach to the problems of animal systematics. This requires that much collecting remains for the future and that even some of the territories previously surveyed may need to be revisited. We call to the attention of those planning and participating in zoological collecting expeditions the possibility and the desirability of saving the blood and obtaining the sera of representative animals in order that a thorough study of the amounts of serological and biochemical correspondence of their blood proteins may be made.

Useful samples of animal bloods and sera may be obtained even with the barest minimum of equipment and facilities. Such samples may serve in "first approximation" studies and may help to indicate where more careful testing is needed.

Let us be realistic and assume that most zoological collecting expeditions will be: (1) short-handed and incapable of devoting more than a minimum of time to extra duties, however desirable from other points of view; (2) unequipped for refined serological collecting; and (3) inexperienced in the standard procedures for collecting and handling animal bloods. And let us also be optimistic in assuming that some members of such expeditions would be willing to give limited help to us and save the bloods and sera of some of the animals obtained in normal routine collecting. What could such people do that would require the very minimum of time, experience, and equipment?

We will discuss the possibilities for collecting animal bloods on two levels, viz., (1) that where no facilities for collecting fluid blood are available and (2) that where fluid blood and sera may be collected but at the minimum level of equipment.

1. Collection of blood without facilities for handling volumes of fluid blood or sera: The simple procedure, for small birds or mammals, is to make use of filter paper or towelling paper to soak up the blood from wounds or the blood and sera from the animal's carcass as it is being skinned. Care should be taken to keep the paper free of fat. Such blood and sera squeezed from the carcasses may be supplemented by blood obtained directly upon cutting open the heart and major vessels. It would be desirable to obtain the equivalent of a 2-inch square of soaked filter paper from a single small bird or mammal, but often this is not possible. In such cases the procedure may be repeated for several individuals of the same species—all on one piece of filter paper if the identification is certain. For a very rare small specimen we will be glad to get anything at all. The fact is that sometimes it is possible to identify the species from a spot of blood no larger than a matchhead. For animals as large as a red fox or larger, it should be possible to obtain the equivalent of a square foot or more of soaked paper from one or more individuals.

The soaked paper should be hung up in the shade to dry at prevailing temperatures, carefully shielded from other papers and from visitations by insects. When thoroughly dry, complete the labelling by writing in pencil, directly on the paper, the scientific name of the specimen, date, locality, whether sample is pooled or single, and name of the collector. If the identification is uncertain and the skin or other parts of the specimen are being preserved for later identification, indicate the specimen number and institution. Wrap the filter paper in protective paper and keep dry until sent to the Serological Museum.

2. Blood collecting where containers for fluid blood, bottles for serum, and preservatives are available: Any clean jar or container may be used for collecting fluid blood from fresh wounds or cuts. Allow the blood to clot in as cool a place as possible (but whole blood should not be frozen). After it has clotted, loosen the blood from the sides of the container and allow it to stand for several hours at room temperatures or overnight at refrigerator temperatures. During this time the serum will usually express itself from the clot as the clot shrinks. Pour off the serum as clear as possible into a serum bottle and add the preservative. A standard preservative is 2% formalin prepared by adding 2 ml of commercial formalin (equivalent to about 40% formaldehyde) to about 98 ml of fresh water. Use one part of this standard 2% formalin to nine parts of serum. The final concentration of formalin in the serum is thus 0.2%, and this has served as a very good field preservative.

If no suitable bottles are available for the storage of the serum, it may be soaked up directly onto the filter paper, and dried as for whole blood.

It is our hope that some useful samples for serological study may be obtained in these ways and that bloods which would otherwise have been lost may thus be salvaged. It is our hope also that through the modest but considerate help of *many* individuals and expeditions it will not be necessary to organize special collecting expeditions to obtain the needed sera. We would appreciate very much therefore, being in-

formed in regard to collecting expeditions while in their planning stages, in time so that we may have the opportunity of explaining our simple needs to those who will be in a position to help. The Serological Museum acts as a kind of world center for the study of comparative serology and has been designated as a Subsection of the Section of Zoology of the International Union of Biological Sciences. It has also been approved as a reception agency for animal bloods and sera from all parts of the world by the U. S. Department of Agriculture, subject to their regulations in regard to the treatment of the bloods and sera so received. We offer services of several kinds to those interested in comparative serology, such as an identification service for blood dots representing the blood meals of insects or other arthropods feeding upon unknown hosts. We offer materials, facilities, and instruction to visiting scientists, and publish a semiannual bulletin, distributed free to those interested in this field of work. Help has already been given us by many cooperating institutions and other agencies and by collectors in many parts of the world. But the task of obtaining representative collections of the sera of animals of many groups is so vast that more help will be needed for a long time to come. The source of all contributions of animal sera will be acknowledged in the scientific reports which concern them.

Inquiries and all other correspondence may be addressed to:

ALAN BOYDEN

Serological Museum
Rutgers University
New Brunswick, New Jersey

Manuscript received April 3, 1953.

Wanted—Definitions

RECENTLY Bauer (SCIENCE **117**, 40 [1953]) made a plea for "Logic and Language in Medical Writing." The other day in quizzing my class the meaning of the word "spore" came up and since no one seemed to know its meaning I assigned them an exercise on the derivation and meaning of the word. I was rather disappointed with the results, but when I looked in the books (including two medical dictionaries) which were available to the students, the only one that I found to have a correct derivation and definition of the term was Webster's *Unabridged Dictionary*.

As samples of the definitions given I quote the following. "A cell in a resistant covering, capable of developing independently into a new individual. Gr. *spora* (sic), seed." This definition would not hold for bacterial spores, which are not reproductive, or for zygospores, which do not develop independently, or for spores which do not have a resistant covering. Another: "A cell which produces a new individual without fertilization." Parthenogenetic eggs do this. A third: "Gr. *spora* (sic). A special reproductive body of one of the lower organisms. It is protected by a resistant covering, and capable of developing independently into a new individual." Same objections as to first definition. A fourth zoology text did not define the word at all.

How can we expect our students to be accurate when their textbooks and even reference books are inaccurate and misleading?

P. H. YANCEY

Department of Biology, Spring Hill College
Mobile, Alabama

Manuscript received March 9, 1953.

Book Reviews

Advances in Cancer Research. Vol. I. Jesse P. Greenstein and Alexander Haddow, Eds. New York: Academic Press, 1953. 590 pp. Illus. $12.00.

This is a remarkably fine collection of reviews in ten lines of investigation on cancer. Every contribution displays thoroughness, sound knowledge, and evaluation of the topic, and a scholarly, scientific approach. This would be anticipated from the authors, each one of whom is an expert research worker in the specific field.

The orientation of the volume is along "fundamental" research. All but two of the reviews deal with some aspect of carcinogenesis. C. A. Coulson's presentation indicates that the high expectations of some years ago in the mathematical formulations that a high condensation of Π-electrons in the so-called K region of condensed polycyclic hydrocarbons is related to carcinogenic property have not been realized.

L. Dmochowski brings up to date the work on the milk agent in the origin of mammary tumors in mice. It is now clear that the milk agent is not essential for the genesis of some of the tumors, and that the milk agent is not essential for the continuous growth of the neoplasms. Rapid progress in the subject still awaits at least partial isolation of the agent and more rapid bioassay methods for its presence. R. J. C. Harris, in describing studies on the Rous virus, where rapid bioassay methods are available, shows how far we still would be from the heart of the problem even if such viruses were available in the pure state. The key problems are the functional organization of cells and the effect of viral invasion upon such function. As such, research on viruses in general, and on cells in general may in the long run contribute more to the understanding of the role of viruses in cancer than the direct study of the few examples of virus-induced neoplasia.

E. V. Cowdry reviews the studies of his group on the cytologic and biochemical events that occur when

the skin of mice is painted with methylcholanthrene. The large amount of data allows no particular conclusions with the possible exception of the relation of reduced calcium content to decreased cohesiveness of cells. Even the general statement that the findings "are consistent with the hypothesis that malignant transformation is one of probably several mutations" is tenable only if the word "mutation" is used in the sense of any change rather than in the more exact genetic meaning of the term.

Much more promising than these overall studies appear to be the more exact tracings of metabolic pathways and of conversion products with the use of radioisotopes, as presented by C. Heidelberger. This reviewer is still highly impressed by the work of J. A. Miller and E. C. Miller, who first clearly presented evidence through their studies on azo dye carcinogenesis that abnormal protein patterns are formed in the process. With successful extension of these investigations to polycyclic hydrocarbons, generalizations of utmost importance are feasible and susceptible to factual experimentation.

W. U. Gardner gives a résumé of data on hormonal aspects of experimental tumorigenesis. Little new information seems to have been added during the past five years, and the era of steroid hormones appears to be drawing to a close in this field. Reports which have appeared since this review, on the effects of hypophysectomy upon carcinogenesis will undoubtedly revitalize the advances. A. Tannenbaum and H. Silverstone review nutrition in relation to cancer, another chapter in cancer research that is fairly well delineated. Diet plays a definite role, albeit a peripheral one, in the genesis of many tumors in animals, and probably in man. Underfeeding leads to a lower incidence and later appearance of many neoplasms, but the nutritional state has no marked effect upon the growth of established cancer.

W. C. J. Ross contributes a technical chemical paper on the cytotoxic alkylating agents, "radiomimetic" compounds, which have found a small place in the clinical chemotherapy of the lymphomas. His review shows the extensive, detailed investigations that have been performed with these agents and, at the same time, reveals the limitations of this type of approach in experimental chemotherapy of cancer. R. J. Winzler presents the subject of plasma proteins in cancer. Although many abnormalities have been shown, none is specific for neoplastic disease and probably reflects the systemic changes in the host. One wonders whether accentuation upon the analysis of the proteins of neoplastic tissues themselves may not be more profitable than further search for possible specific changes which may reside in the proteins of the blood.

For all investigators in cancer, as well as for laboratories of biochemistry, endocrinology, virology, and radiology, *Advances in Cancer Research* is a must. The index of papers scheduled for Volume II indicates that the quality of the presentations will be maintained.

The editors and the publishers are to be congratulated for the initiation of a valuable series of publications.

MICHAEL B. SHIMKIN
Cancer Research Institute
University of California School of Medicine
San Francisco, California

Science and Humanism: Physics in Our Time. Erwin Schrödinger. New York: Cambridge Univ. Press, 1952. 68 pp. $1.75.

> I consider science an integrating part of our endeavour to answer the one great philosophical question which embraces all others, the one that Plotinus expressed by his brief: Who are we? And more than that: I consider this not only one of the tasks, but the task, of science, the only one that really counts (p. 51).

It is customary to say "This is the age of science." And science means to most people radar and atomic energy, jet planes and supersonic flight, miracle cures and wonder drugs. It means all the achievements of modern technology based on science. With this outlook many engaged in industry and technology lose sight of the fact that science is much more—that science has completely changed spiritual values and our whole outlook on the world and its meaning. In the first part of his book, Schrödinger emphasizes this point and strongly urges counteracting the tendency toward technical specialization by a deeper study of the humanistic side of science. He emphasizes the necessity of bringing science to the citizen and he considers lectures, such as these which he gave under the auspices of the Dublin Institute for Advanced Studies, as one of the tasks scientists have to undertake, "for there is always a certain time lag between the views held by learned men and the views held by the general public about the views of those learned men." He also realizes (p. 9) "that the majority of educated persons are not interested in science and are not aware that scientific knowledge forms part of the idealistic background of human life." Thus his introduction is in a sense a summary of the ideas which prompted the development of general education programs not only in this country but also abroad, programs sponsored not only by educators and philosophers but by some of the leading scientists of our time.

The main part of these lectures is devoted to showing how completely physics changed our ideas about the nature of matter, and that, in spite of the fact that modern techniques make it possible to follow a single fast particle and its path, that the nature of this particle and its interaction with matter or radiation is to be described in an entirely different form from what we have been accustomed to.

He discusses the nature of our "models" and brings out the paradoxes of infinity and the difficulty in a continuous description based on causality. This chapter is followed by a lucid and simple discussion of the

meaning of infinity, illustrated by the distribution of numbers in a definite interval—a discussion which will be welcome to teachers who are interested in bringing the meaning of infinity and numbers to the understanding of non-science students.

Schrödinger then discusses the "makeshift of wave mechanics," his own creation, and the idea of complimentarity in the description of particles and waves. While the author speaks whimsically of an "emergency exit" and quotes Eddington as calling it "not a physical theory but a dodge—and a very good dodge, too"—his brief summary is a clear and concise statement of this development, to bring to the attention of the layman the dilemma in the ill-fitting description by words and the perfection of its logical mathematical counterpart in modern physics.

Schrödinger discusses the theory of Bohr and Heisenberg but he, himself, is rather skeptical that this is the last word regarding a theory of nature. "What remains doubtful to me is only just this: Whether it is adequate to term one of the two physically interacting systems the 'subject.' *For the observing mind is not a physical system, it cannot interact with any physical system.* And it might be better to reserve the term 'subject' for the observing mind" (p. 53).

A brief discussion of "atoms or quanta—the counter-spell of old standing, to escape the intricacy of the continuum," follows. Schrödinger closes by discussing: "Would physical indeterminancy give free will a chance?" and considers the problem of predictability in the physical world and in the behavior of a living body. "The net result is that quantum physics has nothing to do with the freewill problem. If there is such a problem, it is not furthered a whit by the latest development in physics. To quote Ernst Cassirer again: 'Thus it is clear . . . that a possible change in the physical concept of causality can have no immediate bearing on ethics.'"

KARL LARK-HOROVITZ
Department of Physics, Purdue University

Record of the Rocks: The Geological Story of Eastern North America. Horace G. Richards. New York: Ronald, 1953. 413 pp. Illus. $6.00.

This is a book on general historical geology in which the emphasis is on the history of a part of eastern North America—the seaboard states from New York to South Carolina. The book is designed for the general student or reader rather than for the specialist and no previous knowledge or study of physical geology or biology is assumed. There are introductory chapters on the principles of physical geology and on the classification of animals and plants.

The treatment of historical geology begins with a short chapter on the origin of the earth. One chapter is devoted to the pre-Cambrian, after which follow chapters on each Paleozoic and Mesozoic period and Cenozoic epoch. A chart of the general section of the rocks for several states is included with each chapter, the physical conditions of the period summarized, paleogeographic maps presented, the prominent life forms described, and the economic resources briefly discussed.

As would be expected from an author who is a well-known specialist on the stratigraphy and paleontology of the Atlantic Coastal Plain, the chapters on the Cretaceous period and on the Tertiary epochs are the most detailed in their discussion of stratigraphic information for the states included.

Extensive reading lists give references to modern literature whereby the serious student can pursue various subjects in any desired detail.

GEORGE W. WHITE
Department of Geology, University of Illinois

Scientific Book Register

Human Behavior: Psychology as a Bio-Social Science. Lawrence E. Cole. Yonkers-on-Hudson, N. Y.: World Book, 1953. 884 pp. Illus. $5.50.

The Scientific Adventure: Essays in the History and Philosophy of Science. Herbert Dingle. New York: Philosophical Library, 1953. 372 pp. $6.00.

Pharmaceutical Arithmetic. A complete course in everyday problems in dispensing, manufacturing, and hospital pharmacy. 3rd ed. Ignatius J. Bellafiore. St. Louis: Mosby, 1953. 226 pp. Illus. $4.50.

The Theory of Homogeneous Turbulence. G. K. Batchelor. New York: Cambridge Univ. Press, 1953. 197 pp. Illus. $5.00.

Applied Inorganic Analysis: With Special Reference to the Analysis of Metals, Minerals, and Rocks (Hillebrand and Lundell). 2nd ed. Revised by G. E. F. Lundell, H. A. Bright, and J. I. Hoffman. New York: Wiley; London: Chapman & Hall, 1953. 1034 pp. Illus. $15.00.

Microscopy for Chemists. Harold F. Schaeffer. New York–London: Van Nostrand, 1953. 264 pp. Illus. $4.50.

Television Receiver Design: I. F. Stages, Book VIII-A. A. G. W. Uitjens. Eindhoven: Philips' Technical Library, 1953. U. S. distrib.: Elsevier, Houston. 177 pp. Illus. $4.50.

X-ray Sieve Therapy in Cancer: A Connective Tissue Problem. Benjamin Jolles. Boston: Little, Brown, 1953. 192 pp. Illus. $6.00.

The Primitive City of Timbuctoo. Horace Miner. Princeton, N. J.: Princeton Univ. Press, 1953. (For the American Philosophical Society). 297 pp. Illus.+ plates. $5.00.

Clinical Periodontology: Dynamics and Treatment; A Biologic Approach to Practice. Abraham Berliner. New York: Park Press, 1953. 249 pp. Illus.

Physical Chemistry for Colleges. A course of instruction based upon the fundamental laws of chemistry. 7th ed. E. B. Millard. New York–London: McGraw-Hill, 1953. 618 pp. $6.00.

The Universe of Meaning. Samuel Reiss. New York: Philosophical Library, 1953. 227 pp. $3.75.

Engineering Descriptive Geometry. The direct method for students, draftsman, architects, and engineers. 2nd ed. Charles Elmer Rowe and James Dorr McFarland. New York–London: Van Nostrand, 1953. 352 pp. Illus. $5.00; $4.25 college ed.

In 1949 We Published —

The Fundamentals of Comparative Embryology of The Vertebrates

Revised Edition by Alfred F. Huettner

This text prepares students for a thorough appreciation of human embryology. It discusses in ascending order, the amphioxus, the frog, the chick, and the pig. The revision includes two new chapters: *History and Theories of Development* and *The Embryology of the Pig.* The descriptive continuity remains intact, although it is highlighted by the addition of certain phases of experimental embryology. There are 26 new drawings and many older illustrations are changed.

1949 309 pp. $5.50

And in 1953 —

A Laboratory Manual of Comparative Embryology

by Alfred F. Huettner

The manual, coordinated with the text, assists both the instructor and the student in a basic course in embrology. Each exercise is divided into two parts: (a) directions and discussion: and (b) the laboratory worksheet for executing the assignments discussed.

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July 18. American Mathematical Society (58th Summer Meeting). Kingston, Ontario.

July 18. Conference on Ionisation Phenomena in Discharges. Oxford, England.

July 19–26. Congress of the Latin American Society of Orthopaedics and Traumatology (2nd). Rio de Janeiro.

July 20–23. American Veterinary Medical Association. Toronto.

July 20–25. International Congress on Medical Librarianship. London.

July 22–24. American Farm Research Association, 1953 Conference. Iowa State College, Ames, Iowa.

July 24–25. Physiological Society Meeting. Cambridge, England.

July 25–28. International Committee of Electrochemical Thermodynamics and Kinetics (5th Annual). Stockholm, Sweden.

July 26–30. International Psychoanalytical Congress (28th). London.

July 26–31. International Congress of Gynaecology and Obstetrics. Geneva.

July 26–31. International Congress on Rheology (2nd). Oxford University, England.

July 27–Aug. 1. International Congress of Psychology. Paris.

July 27–Aug. 1. International Association of Psychotechnology, 11th Congress. Paris, France.

July 29–30. International Symposium on the Chemistry of Natural Products. Wayne University, Detroit, Mich.

July 29–Aug. 4. International Congress of Pure and Applied Chemistry and International Union of Pure and Applied Chemistry. Stockholm.

July 30–Aug. 1. Wyoming Geological Association. University of Wyoming, Field Conference. Laramie.

Aug. 1–7. International Astronomical Congress. Zurich, Switzerland.

Aug. 3. International Union of the History of Science, Third General Assembly, and International Congress of the History of Science, Seventh. Jerusalem.

Aug. 3–5. Abnormal and Pathological Plant Growth. Brookhaven National Laboratory, Upton, L. I., N. Y.

Aug. 3–8. World Meteorological Organization, Regional Assoc. for North and Central America, First Session. Toronto, Canada.

Aug. 4–8. Photographic Society of America. Los Angeles, Calif.

Aug. 5. Symposium on Macromolecules. Uppsala, Sweden.

Aug. 5–12. International Congress of Zoology. Copenhagen.

Aug. 7–8. Pennsylvania Academy of Science (Summer). Thiel College, Greenville, Pa.

Aug. 9. International Veterinary Congress (15th). Stockholm.

Aug. 10–14. Society of American Bacteriologists (Annual). San Francisco.

Aug. 10–18. American Association of Colleges of Pharmacy (Annual). Salt Lake City, Utah.

Aug. 11–14. Canadian Teachers Federation, Alpine Inn, Ste. Marguerite, Quebec, Canada.

Aug. 12–18. International Congress on Home Economics (8th). Edinburgh, Scotland.

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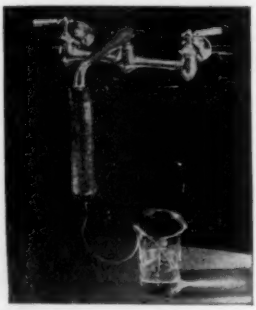

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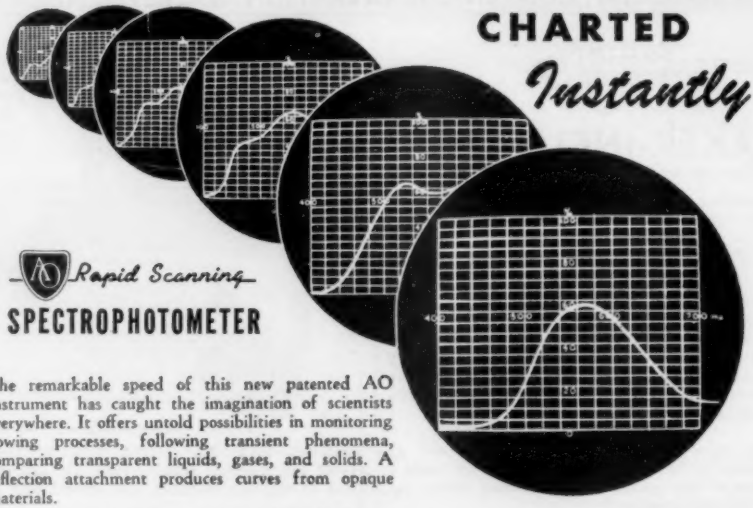

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